AD NUMBER

AD820869

LIMITATION CHANGES

TO:

Approved for public release; distribution is unlimited. Document partially illegible.

FROM:

Distribution authorized to U.S. Gov't. agencies and their contractors; Critical Technology; JUN 1967. Other requests shall be referred to Air Force Technical Application Center, Attn: VSC, Washington, DC 20333. Document partially illegible. This document contains export-controlled technical data.

AUTHORITY

usaf ltr, 25 jan 1972

TR 67-19

TECHNICAL REPORT NO 67-19

SEISMIC NOISE SURVEY, VOLUME 3

LONG-RANGE SEISMIC MEASUREMENTS PROGRAM

GEOTECH
A TELEDYNE COMPANY

DISCLAIMER NOTICE

THIS DOCUMENT IS THE BEST QUALITY AVAILABLE.

COPY FURNISHED CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

TECHNICAL REPORT NO. 67-19

SEISMIC NOISE SURVEY, VOLUME 3
LONG-RANGE SEISMIC MEASUREMENTS PROGRAM

by

Carlos Pena

GEOTECH
A TELEDYNE COMPANY
3401 Shiloh Road
Garland, Texas

29 June 1967

CONTENTS

ILLUSTRATIONS

* * * * * * * * * * *

TABLES

ABSTRACT

This report is the third in a series of studies which evaluate seismic noise levels at LRSM sites. Data from the short- and long-period vertical seismographs from 33 sites are reviewed, and standardized data compilation methods are discussed. Cumulative probability distribution of amplitude curves and noise spectrum curves are developed for each site studied.

SEISMIC NOISE SURVEY, VOLUME 3
LONG-RANGE SEISMIC MEASUREMENTS PROGRAM

1. INTRODUCTION

This report is volume 3 of a series of reports[1] which presents the results of seismic noise measurements taken from data recorded at the Long-Range Seismic Measurements (LRSM) Program field sites. Figure 1 shows the locations and designations of the sites evaluated in this report.

Measurements were taken from data recorded by the vertical seismographs at 33 sites during 1964 - 1966. Franklin, West Virginia (FN-WV) and Fort Stockton, Texas (FO-TX) did not have long-period seismographs, and the surveys of these sites are, therefore, limited to the short-period vertical seismographs. Surveys for both short- and long-period systems are included for 31 sites. The noise survey was conducted at each site after a sufficient time (2 weeks) had elapsed after initial setup to assure that all instruments had stabilized.

This work was done under Project VT/6703, Contracts F33657-67-C-1457 and AF 33(657)-16270. This project is under the technical direction of the Air Force Technical Applications Center (AFTAC) and the overall direction of the Advanced Research Projects Agency (ARPA).

2. DATA PRESENTATION

2.1 Table 1 gives general information about each site. It includes the noise occurrence at the 50 percent level for the short-period and long-period systems and the predominant periods of the noise. Sites are listed in alphabetical order.

2.2 The frequency response of the short-period systems are shown in figure 2. Figure 3 shows the frequency response of the long-period systems at all sites.

---

[1] Technical Report No. 65-25, Seismic Noise Survey, Volume 2, dated 6 April 1965 and Technical Report No. 63-45, Seismic Noise Survey, Volume 1, dated 30 April 1963. In addition, numerous standard noise surveys have been published as supporting or complementary data in special studies and letter reports.

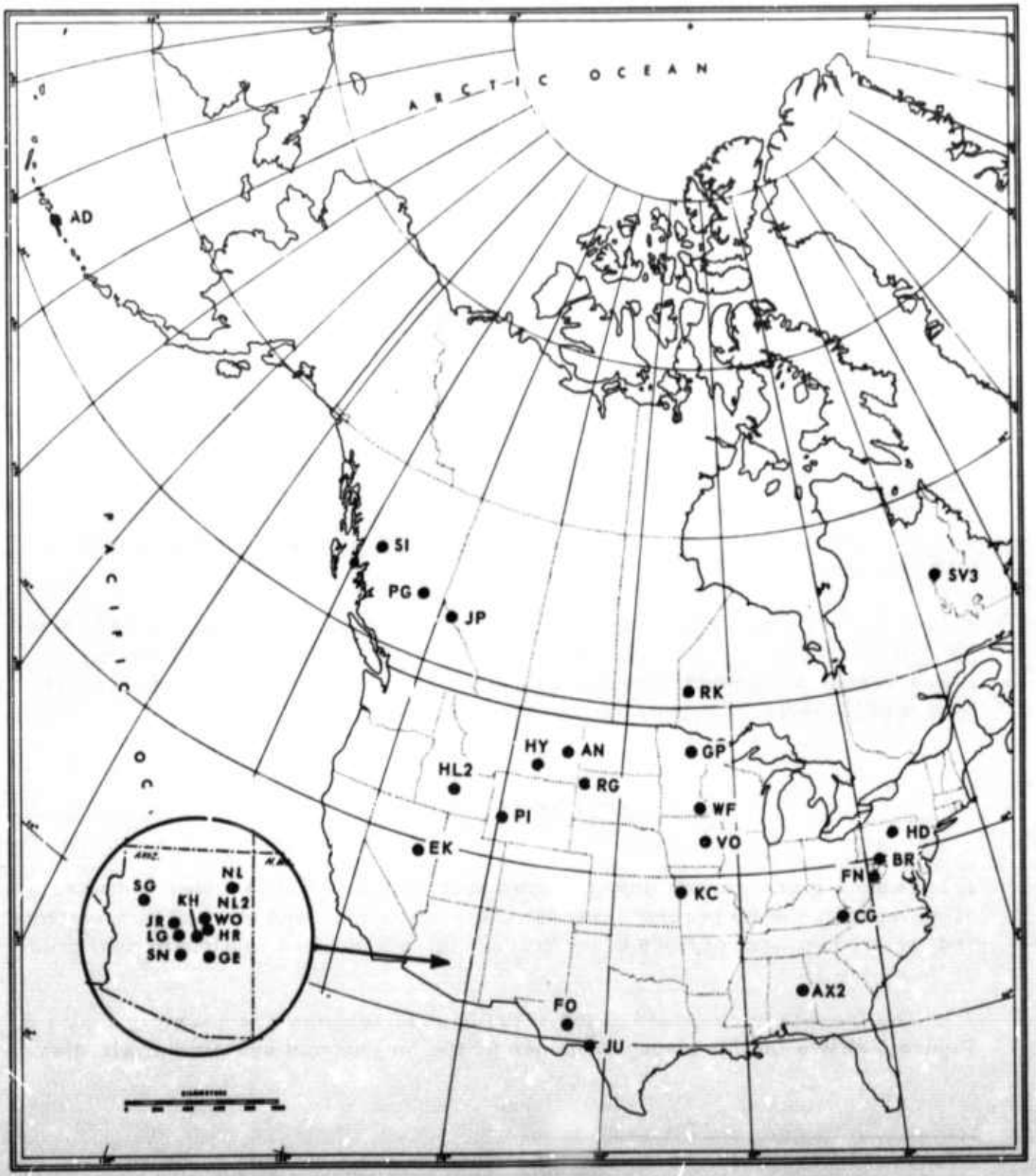


Figure 1. Location of LRSM sites, background NOISE SURVEY

Table 1. LRSM site information

	Site designator	Elevation (km)	Type of installation	Large or small Benioff seismometer	50% Noise Level (nm) SP	LP	Predominate per. of noise (sec) SP	LP	Average magnification (K) SP	LP	Geology	Weathering
Adak Island, Alaska	AD-IS	0.06	Vault	Large	53.0	140	1.2	10, 15	42	25	Glacial drift	None
Angela, Montana	AN-MA	0.91	Vault	Large	6.9	150	0.5	15	210	22	Sandstone-shale	Moderate
Alexander City, Alabama	AX2AL	0.21	Vault	Large	9.7	301	0.4	15	183	40	Sandy clay	Moderate
Berlin, Pennsylvania	BR-PA	0.65	Vault	Large	11.0	460	0.3	25	140	9.7	Sandstone-shale	Moderate
Cumberland Gap, Virginia	CG-VA	0.40	Vault	Large	7.5	300	1.0	30	410	22	Dolomitic limestone	Deep
Eureka, Nevada	EK-NV	1.95	Vault	Large	2.5	210	1.0	15, 20	630	42	Sandstone	Shallow
Franklin, West Virginia	FN-WV	0.91	Vault	Small	6.6	--	1.0	--	170	--	Alluvium	None
Fort Stockton, Texas	FO-TX	0.88	Vault	Small	8.9	--	0.4	--	360	--	Alluvium	None
Globe, Arizona	GE-AZ	1.48	Vault	Large	4.5	470	0.4	5	350	21	Altered shale	Shallow
Grand Rapids, Minnesota	GP-MN	0.43	Vault	Small	13.0	400	1.0	35	140	20	Glacial drift	None
Howard, Pennsylvania	HD-PA	0.37	Vault	Small	29.0	270	0.3	10, 15	100	8.3	Sandy clay	Moderate
Hailey, Idaho	HL2ID	1.83	Mine	Large	1.6	326	0.4	10	390	20	Basalt-limestone	None
Heber, Arizona	HR-AZ	1.88	Vault	Large	3.0	170	0.7, 1.0	15	400	21	Limestone	Shallow
Hysham, Montana	HY-MA	0.98	Vault	Large	6.0	130	0.3	15	180	16	Loose sand	Moderate
Jasper, Alberta, Canada	JP-AT	1.12	Vault	Large	10.0	140	0.5, 0.6	10, 15	146	43	Sandstone-shale	Shallow
Jerome, Arizona	JR-AZ	1.31	Vault	Large	12.0	230	0.3	15	250	22	Limestone	Shallow
Juno, Texas	JU-TX	0.53	Vault	Large	4.0	126	1.0	20	630	24	Alluvium	None
Kansas City, Missouri	KC-MO	0.27	Vault	Small	34.0	170	0.4	10	48	39	Limestone shale	Moderate
Kohle Ranch, Arizona	KH-AZ	2.29	Vault	Large	19.9	460	0.6	15, 35	97	12	Residual soil	Deep
Long Valley, Arizona	LG-AZ	1.77	Vault	Small	9.0	360	1.0, 1.2	15	250	52	Tuff-basalt	Shallow
Naalini, Arizona	NL-AZ	1.77	Vault	Large	6.4	530	0.4	35	260	7.0	Claystone	Shallow
Naalini, Arizona	NL2AZ	1.92	Vault	Large	3.4	240	0.4, 0.5	15	350	20	Alluvium	None
Pinedale, Wyoming	PI-WY	2.17	Vault	Small	3.7	600	1.0	10	280	5.4	Sandstone	Moderate
Prince George, British Columbia	PG-BC	0.91	Vault	Large	6.8	210	0.7	15	23	90	Gneiss	Moderate
Redig, South Dakota	RG-SD	0.92	Vault	Large	18.0	290	0.4	10	64.5	11	Granite	Shallow
Red Lake, Ontario, Canada	RK-ON	0.36	Vault	Small	5.2	480	0.6	45	204	22	Granite	Shallow
Seligman, Arizona	SG-AZ	1.68	Vault	Large	3.0	150	0.5, 0.6	15	440	12	Sandy limestone	Shallow
Smithers, British Columbia	SI-BC	0.57	Vault	Large	14.0	470	1.4	35	154	25	Sandstone	Moderate
Sunflower, Arizona	SN-AZ	0.88	Vault	Large	2.6	300	1.0, 1.2	5	370	18	Granite	Shallow
Schefferville, Quebec	SV3QB	0.57	Vault	Small	24.0	385	1.0	15, 30	75	32.6	Glaciel	Moderate
Vinton, Iowa	VO-IO	0.27	Vault	Small	22.0	330	1.0	15	95	17	Limestone	Shallow
Winslow, Arizona	WO-AZ	1.58	Vault	Large	7.5	250	0.4	15	310	50	Sandstone	Shallow
Wykoff, Minnesota	WF-MN	0.38	Vault	Small	20.0	350	1.2	15, 30	120	28	Dolomitic limestone	Shallow

-- No LP instruments

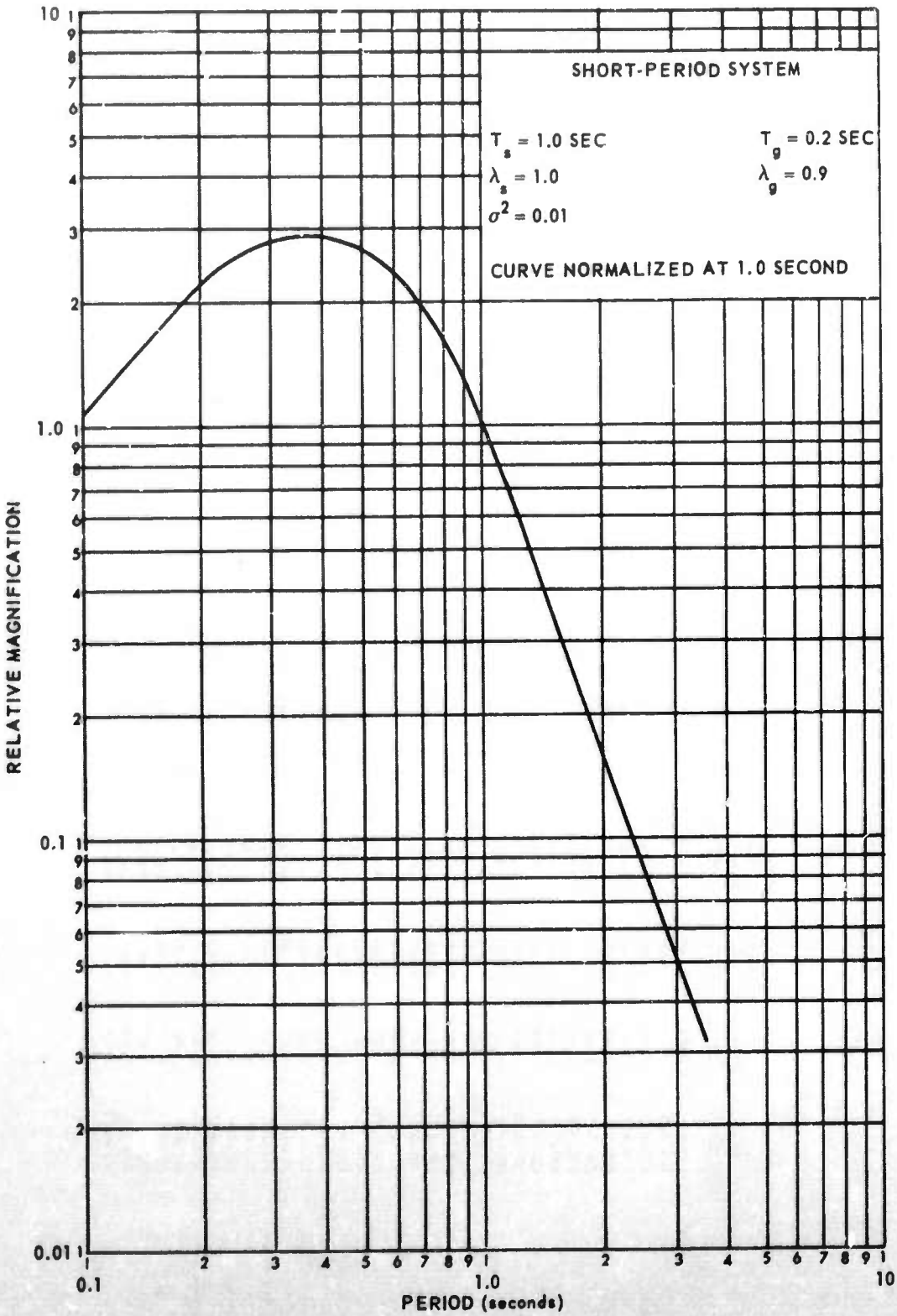


Figure 2. Frequency response of the short-period seismograph system

G 2889

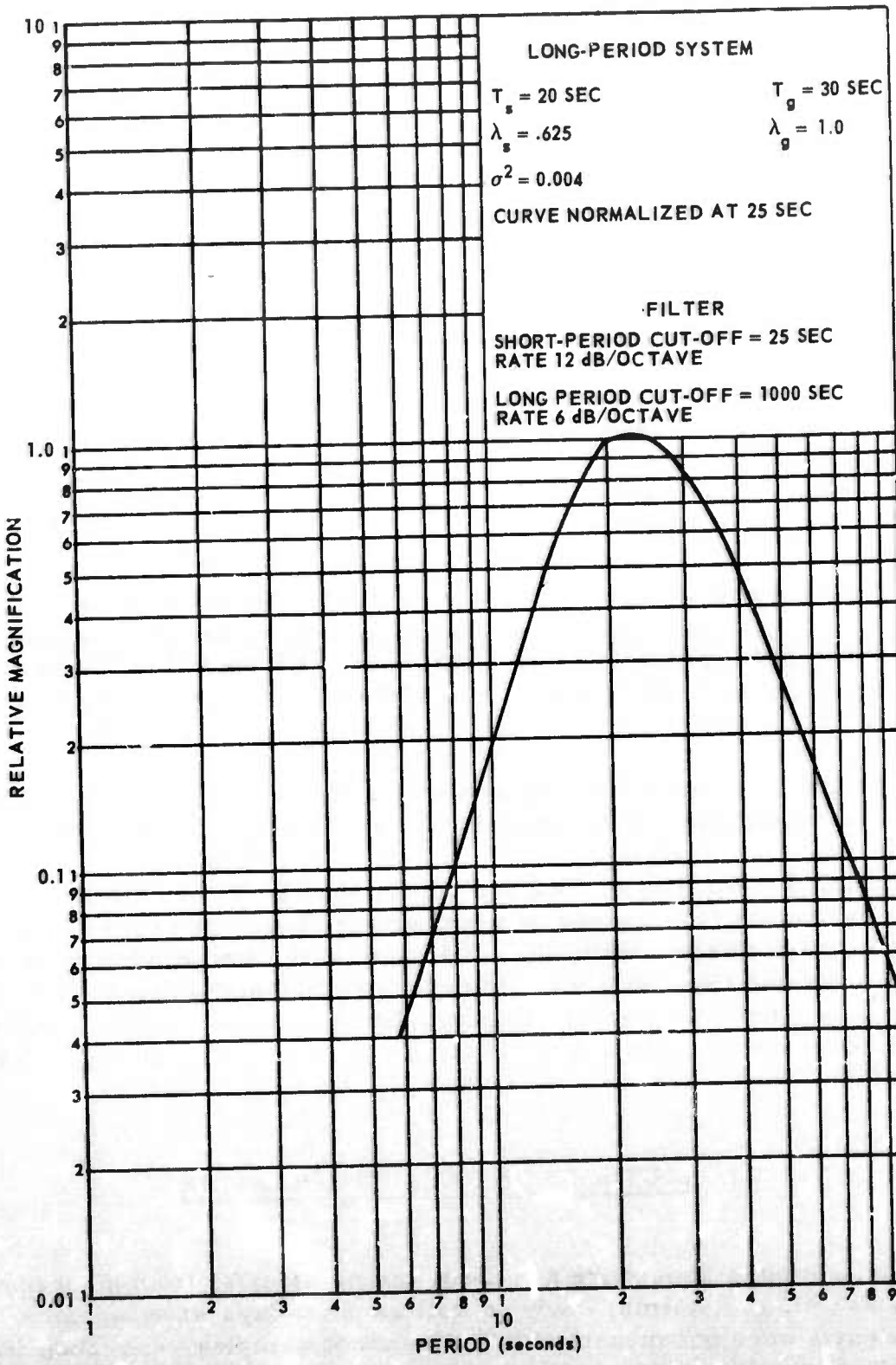


Figure 3. Frequency response of the long-period seismograph system

2.3 Appendix 1 contains curves which show the percentage of occurrence of short-period noise versus recorded amplitude in millimeters (peak-to-peak) divided by the magnification at 1 cps. Amplitude measurements were made in the period range of 0.3 to 1.4 seconds. The amplitudes taken from the 35 mm film recordings were divided by the magnification at 1 cps to reduce the data from all sites to a common reference. Thus, the noise occurrence curves give a measure of the normalized noise as seen on film and do not give a true measure of earth motion except at 1 cps. Appendix 2 contains curves which show the percentage of occurrence of long-period noise versus recorded amplitude in millimeters (peak-to-peak) divided by the magnification. Amplitude measurements were made in the period range of 6 to 100 seconds. The amplitudes from the film were divided by the magnification at 25 seconds to reduce the data to a common reference. Thus, the curves give a measure of normalized noise as seen on film and do not give a true measure of earth motion, except at 25 seconds.

2.4 Appendix 3 contains noise spectrum curves. The average amplitude in millimicrons, corrected for instrument response, is plotted as a function of period. The measurements cover a period range from 0.3 to 1.4 seconds for the short-period systems and from 6 to 100 seconds for the long-period systems.

2.5 Appendix 4 contains histograms showing the percentage of occurrence of noise at given periods for the short-period and long-period systems.

At X20 magnification 1 mm = 0.2 seconds on the short-period film seismograms. This can introduce bias caused by a tendency for analysts to read in even increments of period, for example, 0.2, 0.4, 0.6, etc. Recognizing this, efforts are made to avoid this tendency. The short-period histogram for EK-NV exhibits a saw-tooth appearance favoring the even periods. Additional data will be analyzed from this site and the results will be published in Noise Study No. 4.

3. METHODS OF DATA COMPILATION

A random sampling procedure was used, taking samples from night operating periods as well as daytime, windy as well as quiet days were sampled. Earthquake signals were not measured. Two hundred samples were taken from each team. The samples were read from 35 mm film at X20 magnification. The maximum trace amplitude present within the given period range was measured from peak-to-peak, to the nearest 0.5 millimeter; periods were measured to the nearest 0.1 second on the short-period records and to the nearest 1 second on the long-period records. Table 2 lists the period correction factors used to plot the noise spectrum curves.

Table 2. Period correction factors

Period (seconds) SP	Correction factor	Period (seconds) LP	Correction factor
0.3	0.357	6	22.727
0.4	0.344	7	14.925
0.5	0.377	8	10.000
0.6	0.418	9	7.246
0.7	0.497	10	5.319
0.8	0.591	15	1.724
0.9	0.769	20	1.042
1.0	1.000	25	1.000
1.1	1.234	30	1.176
1.2	1.538	35	1.515
1.3	1.923	40	2.000
1.4	2.380	45	2.778
		50	3.636
		55	4.651
		60	5.882
		65	7.143
		70	8.696
		75	10.638
		80	12.987
		85	15.152
		90	17.544
		95	20.000
		100	22.727

4. CONCLUSIONS

4.1 GENERAL

The geologic structure at each of the sites used for this report must be regarded as a variable which affects background noise.

There are several instances where sites, which are located on virtually the same type of geologic medium, have widely different noise levels. An explanation of this difference in levels does not readily present itself. However, many factors must naturally be considered in drawing conclusions from studies of the type dealt with in this report. Some of the most apparent factors are:

a. The depth and extent of weathering of the geologic medium;

b. The particular type of geology. In some cases, the composition of the medium may vary from point to point, which in turn causes variation of the noise level;

c. The adequacy of seismometer vault protection procedures, that is, how well the vaults are sealed, how much covering they have, and the relative depth (with respect to ground level) of the seismometer emplacements;

d. The environment (trees near the instruments, wind exposure and velocity, general climatic differences of various sites);

e. Cultural noise; activity near the site (traffic, mining, or logging operations).

All of the above factors, separately and in combination, act on the sites' data. The extent of variation caused by these factors is, however, beyond the scope and purpose of this report.

4.2 OBSERVATIONS ON SHORT-PERIOD DATA

4.2.1 Four sites were located on limestone, and short-period noise (at the 50 percent occurrence level) at three of these (Heber, Arizona, Jerome, Arizona and Vinton, Iowa) measured less than 22 millimicrons. The fourth site, Kansas City, Missouri, measured 34 millimicrons.

4.2.2 There were three sites located on granite. Of these, the maximum noise level (at 50 percent occurrence) was 18 millimicrons, which occurred at Redig, South Dakota. The noise level at Red Lake, Ontario was computed to be 5.2 millimicrons and Sunflower, Arizona was 2.6 millimicrons.

4.2.3 Seven sites were located on sandstone; noise levels ranged from 2.5 millimicrons at Eureka, Nevada to 14 millimicrons at Smithers, British Columbia.

4.2.4 Twenty-one of the 33 sites included in this report exhibited noise levels (at the 50 percent occurrence level) of 10 millimicrons or less.

4.3 OBSERVATION ON LONG-PERIOD DATA

4.3.1 For the majority of the sites studied, noise from the long-period systems was predominantly in the 10-15 second period range.

4.3.2 It is impractical to correlate long-period noise level on the basis of geology alone.

4.3.3 Noise at the 50 percent occurrence level ranges from 120 millimicrons at Juno, Texas, to 600 millimicrons at Pinedale, Wyoming; noise at the remainder of the sites studied showed a random variation between these low and high levels. The average noise level from all sites is approximately 305 millimicrons.

4.4 OBSERVATIONS ON THE NAZLINI, ARIZONA SITES

The site which was designated NL-AZ was operated for the 10-month period April 1964 through January 1965. At this time the site was moved approximately 7 miles to take advantage of more stable soil in which to emplant the seismometer vaults. The new site, designated NL2AZ, became operational during mid-February 1965 and was closed early in October 1965.

In terms of background noise level, the move appears to have been propitious. The average noise levels (not corrected for period) of the vertical components at the two sites are summarized below:

	Vertical SP	LP Vertical
NL-AZ	6.4 mμ	530 mμ
NL2AZ	3.4 mμ	240 mμ

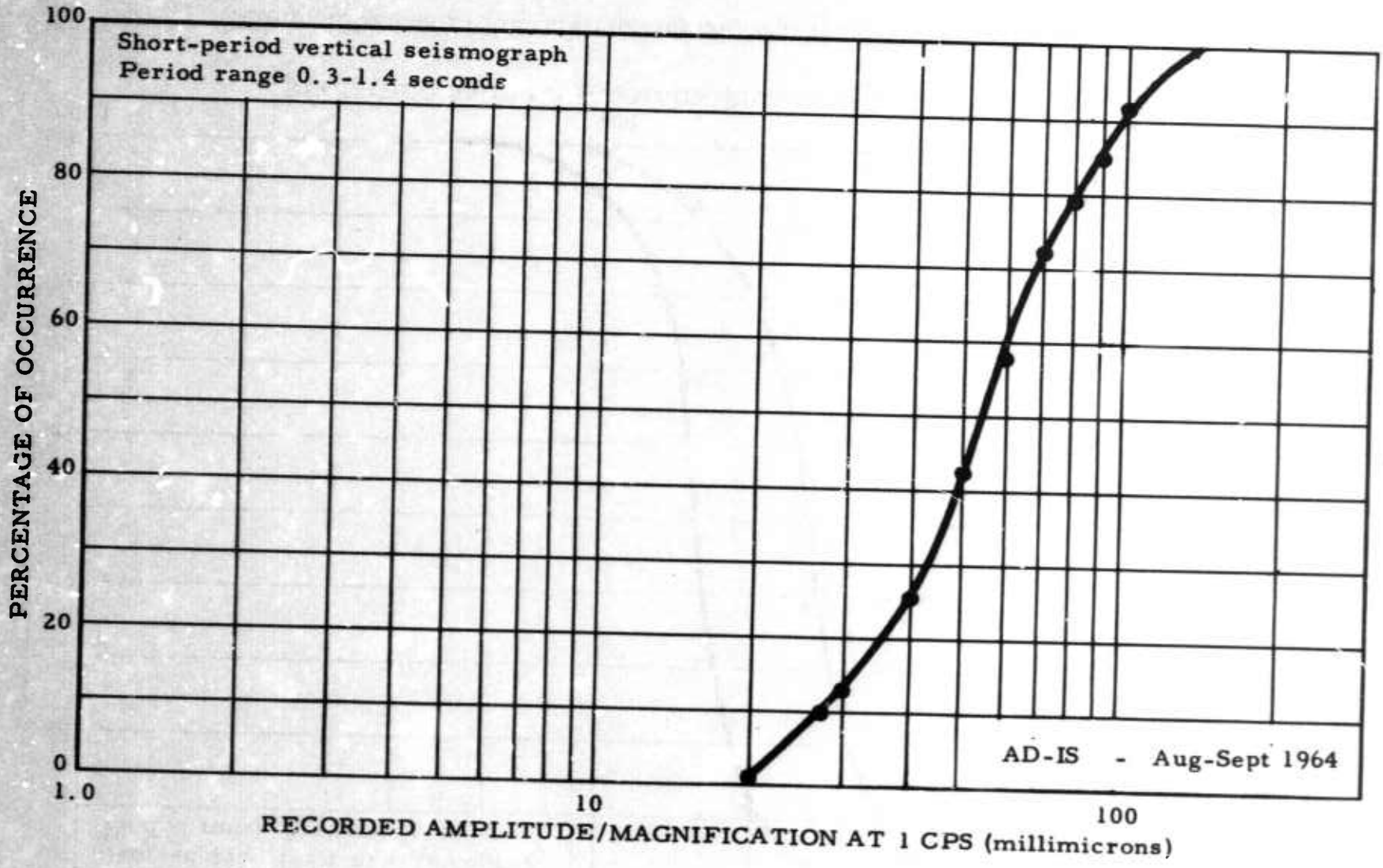
A comparison of the average operating magnifications of the two seismographs support the data shown above. The average magnification of the short-period vertical seismograph at NL-AZ was 260K; at NL2AZ it increased to 350K. The average long-period vertical magnification increased nearly 200 percent (from 7K to 20K) as a result of the site relocation.

5. ACKNOWLEDGMENTS

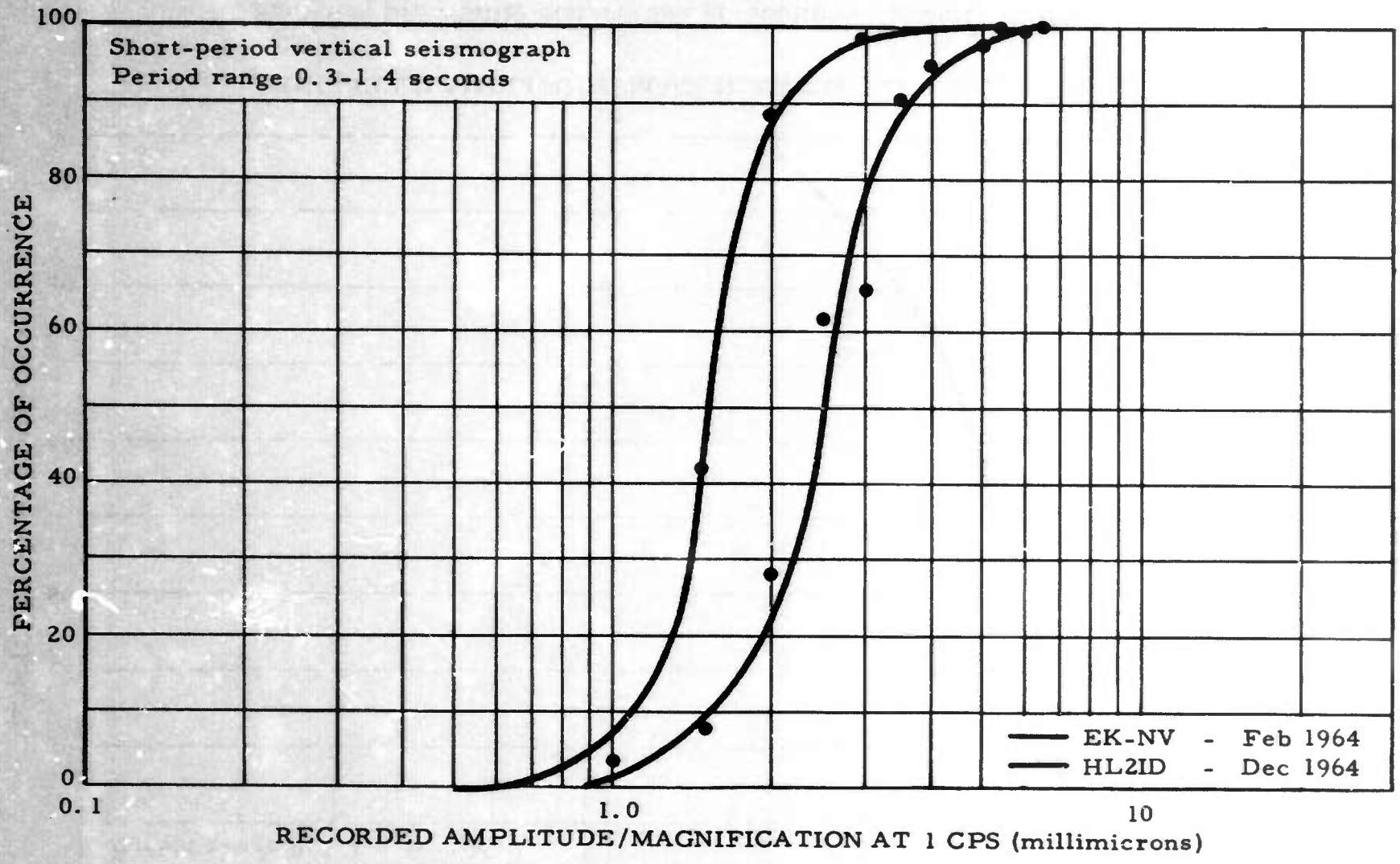
The author wishes to express his thanks to the members of the Data Reduction Section, LRSM, for their help in taking the noise samples and preparing drafts of the several curves included in this report.

APPENDIX 1 to TECHNICAL REPORT NO. 67-19

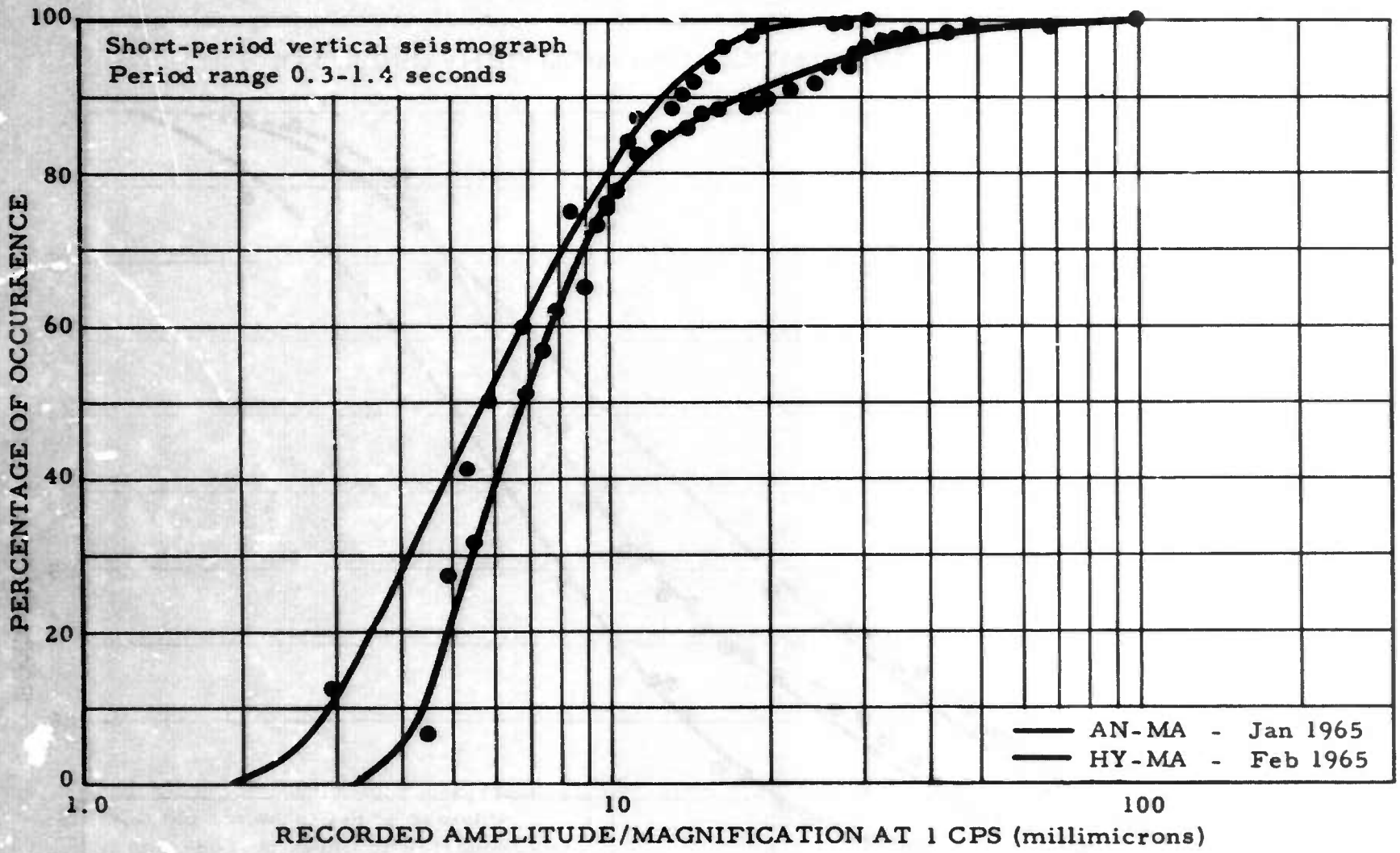
SHORT-PERIOD NOISE OCCURRENCE CURVES



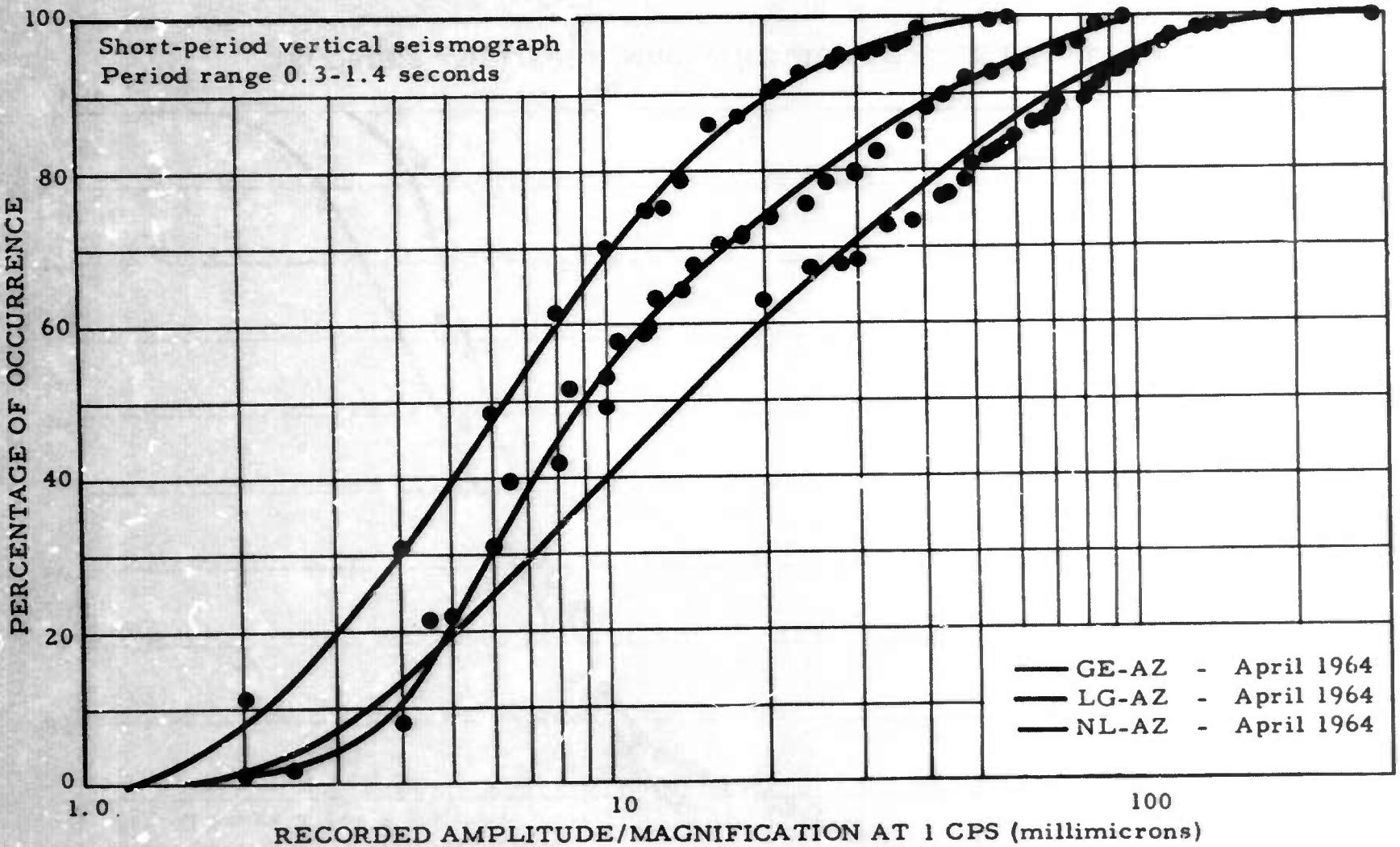
Cumulative probability distribution of amplitude, standard LRSM survey



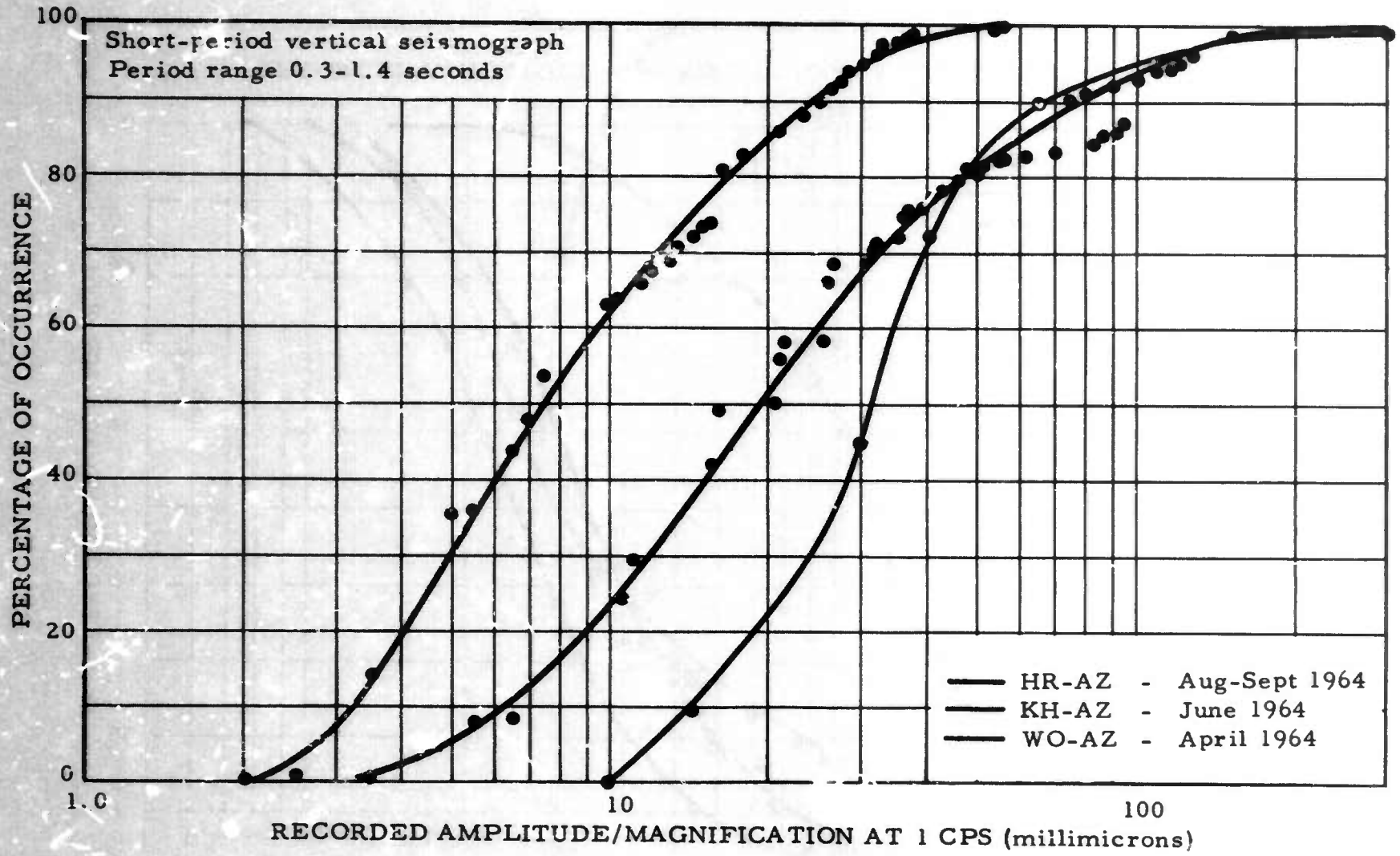
Cumulative probability distribution of amplitude, standard LRSM survey



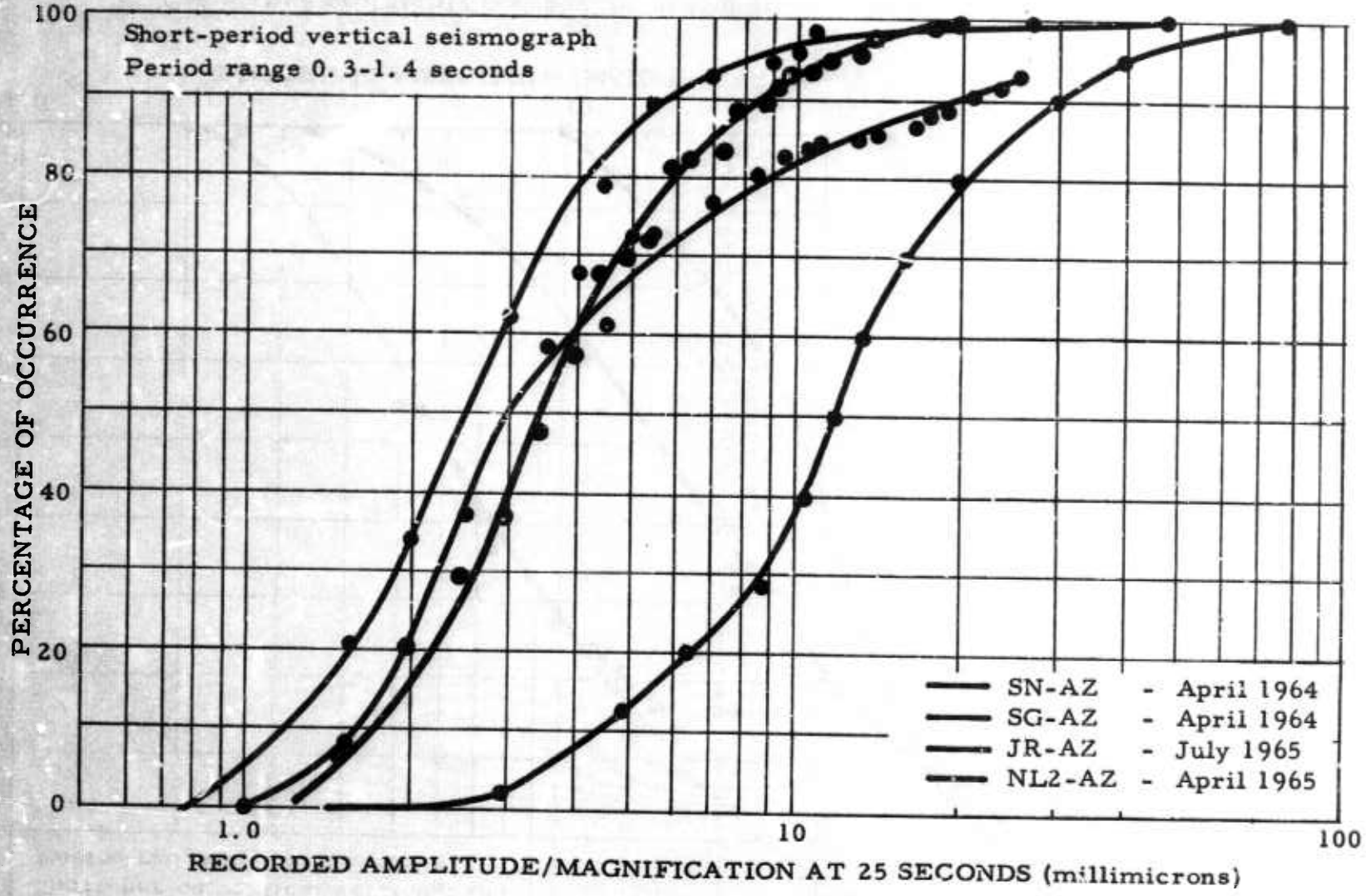
Cumulative probability distribution of amplitude, standard LRSM survey



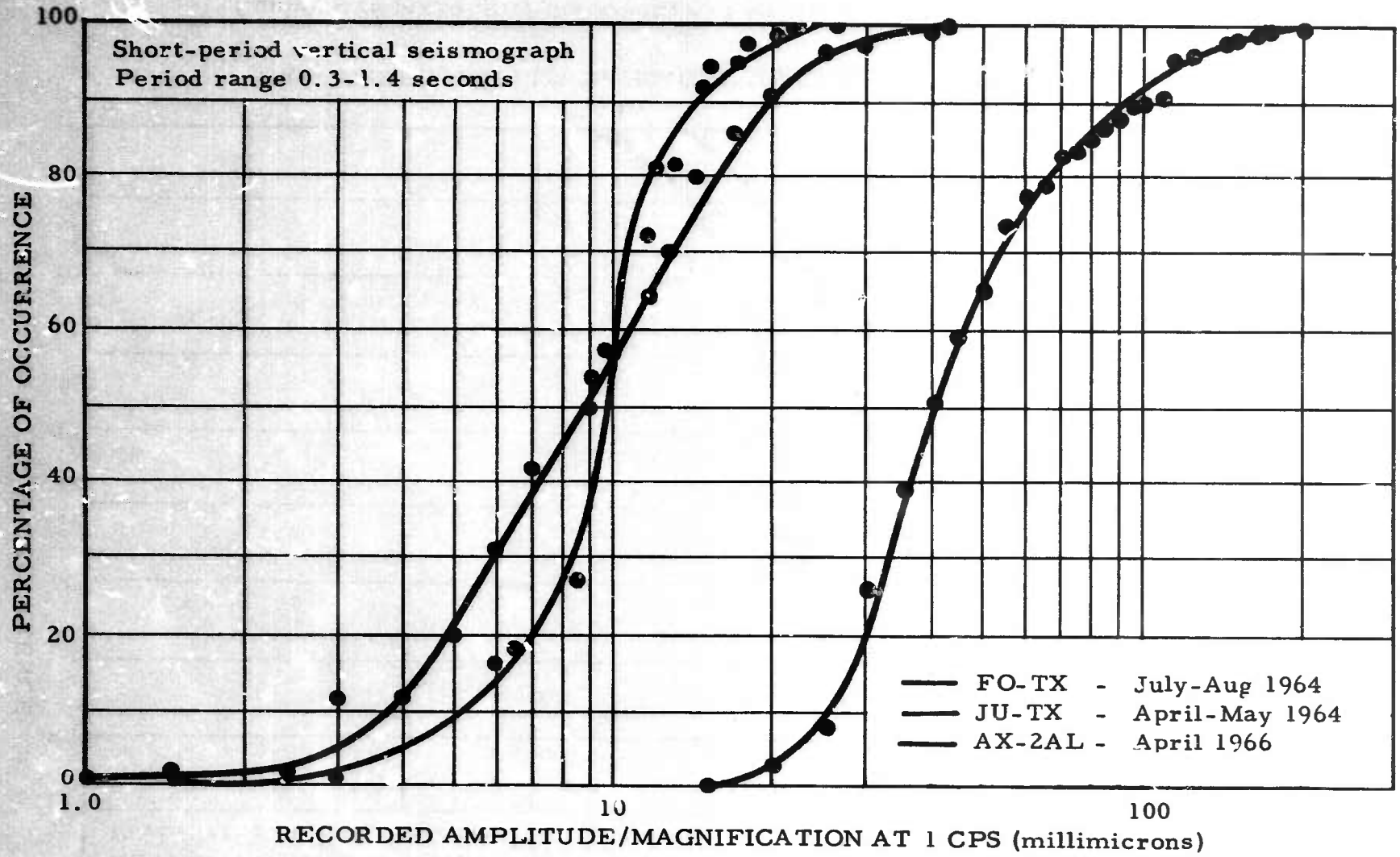
Cumulative probability distribution of amplitude, standard LRSM survey



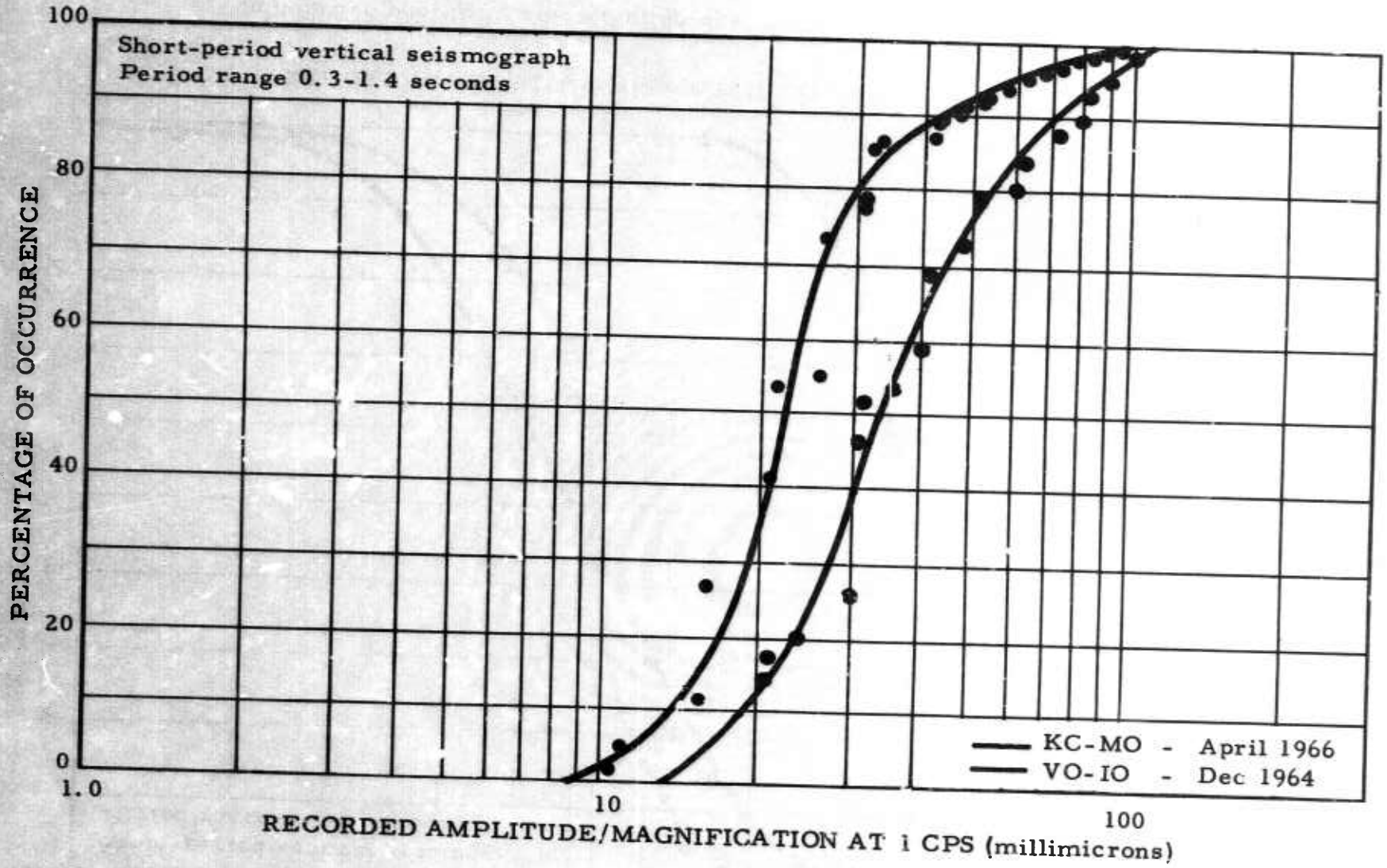
Cumulative probability distribution of amplitude, standard LRSM survey



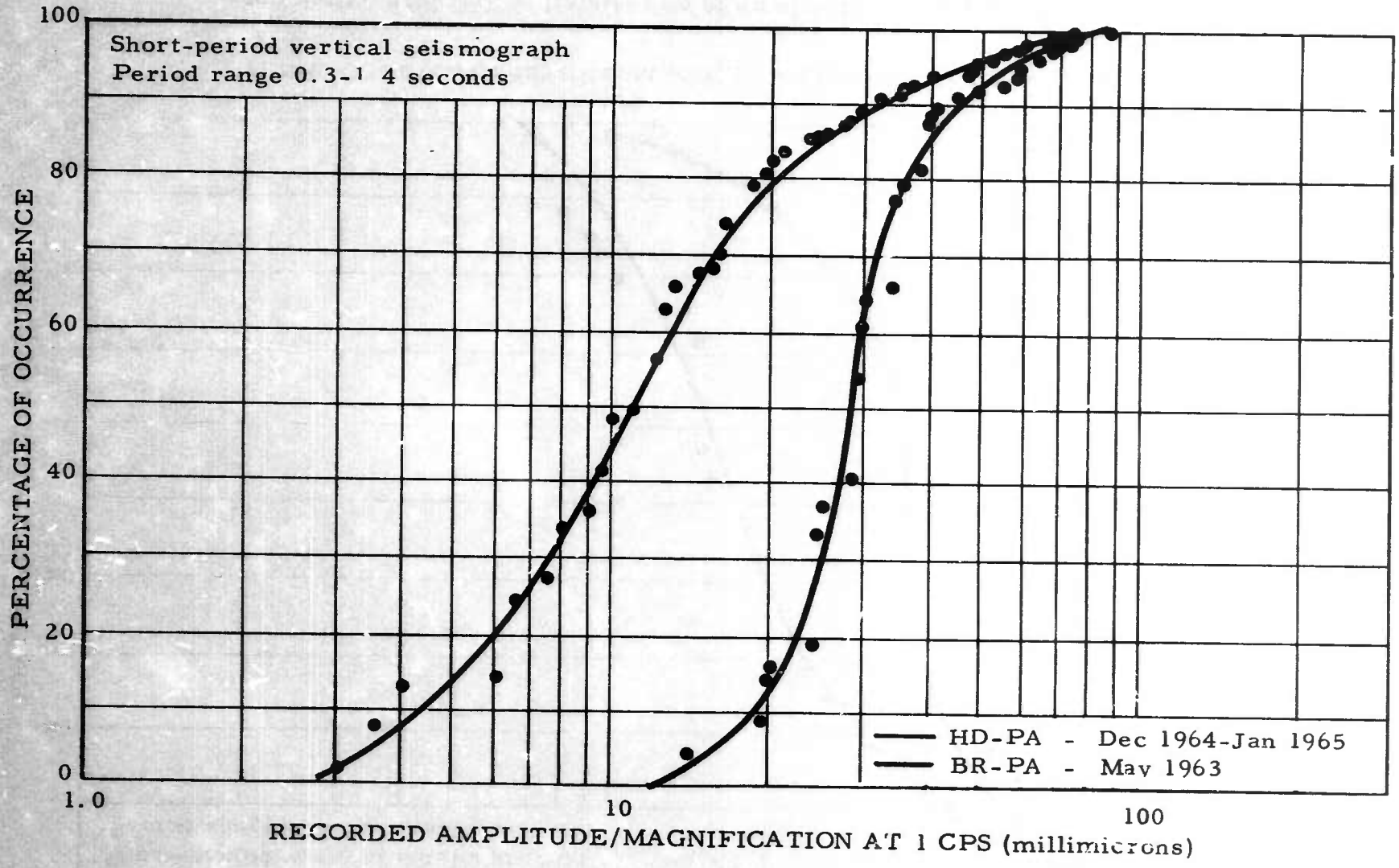
Cumulative probability distribution of amplitude, standard LRSM survey



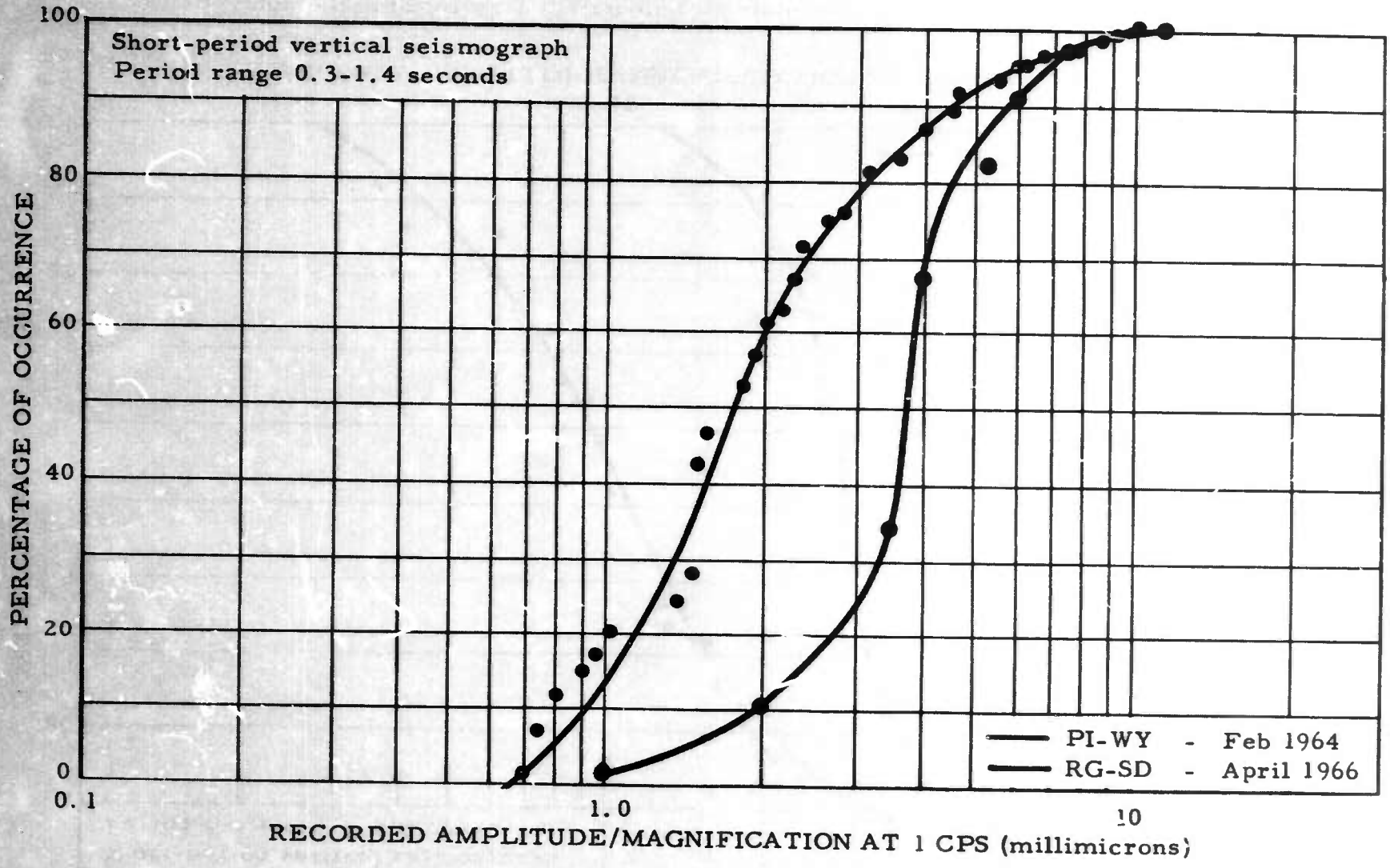
Cumulative probability distribution of amplitude, standard LRSM survey



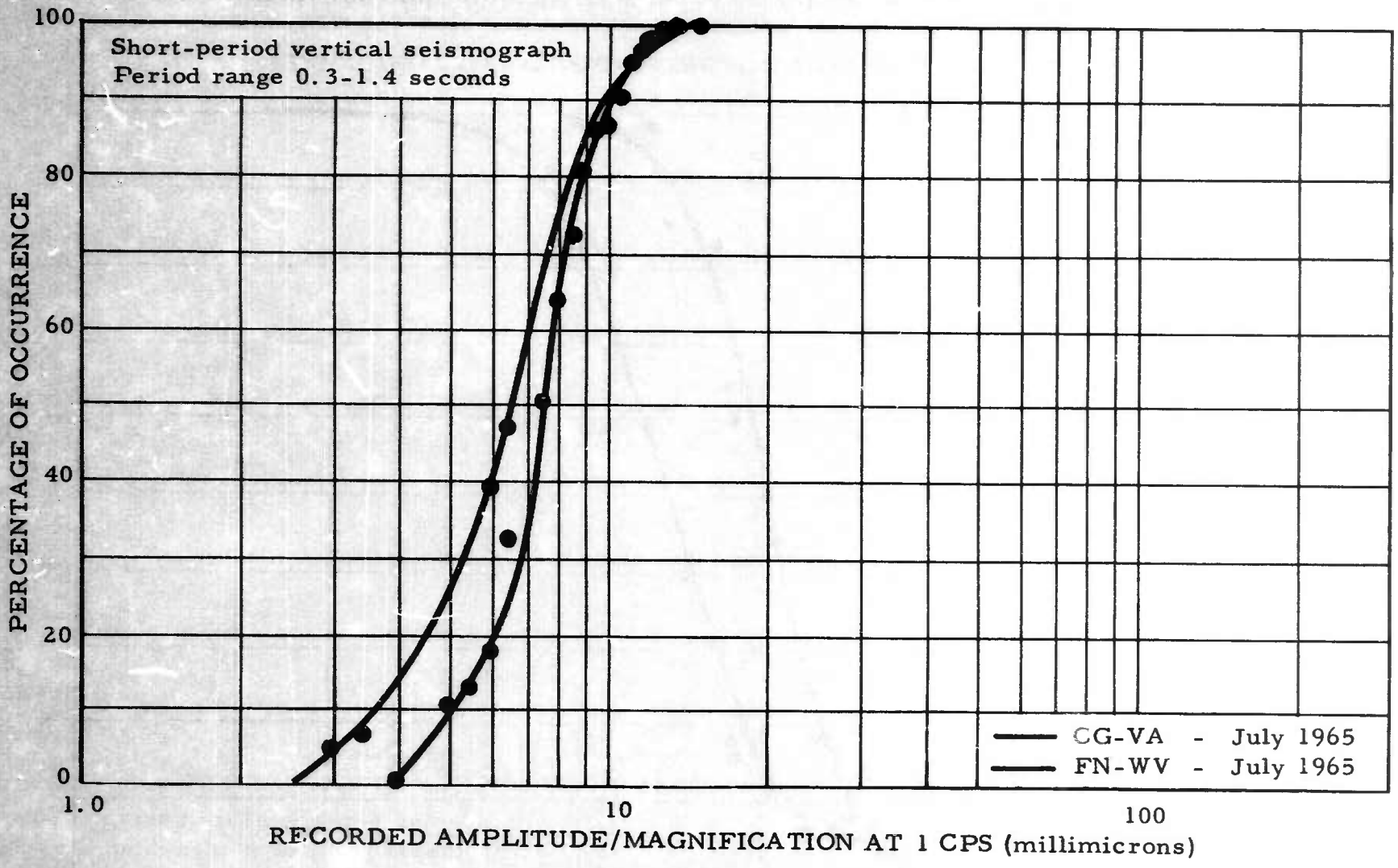
Cumulative probability distribution of amplitude, standard LRSM survey



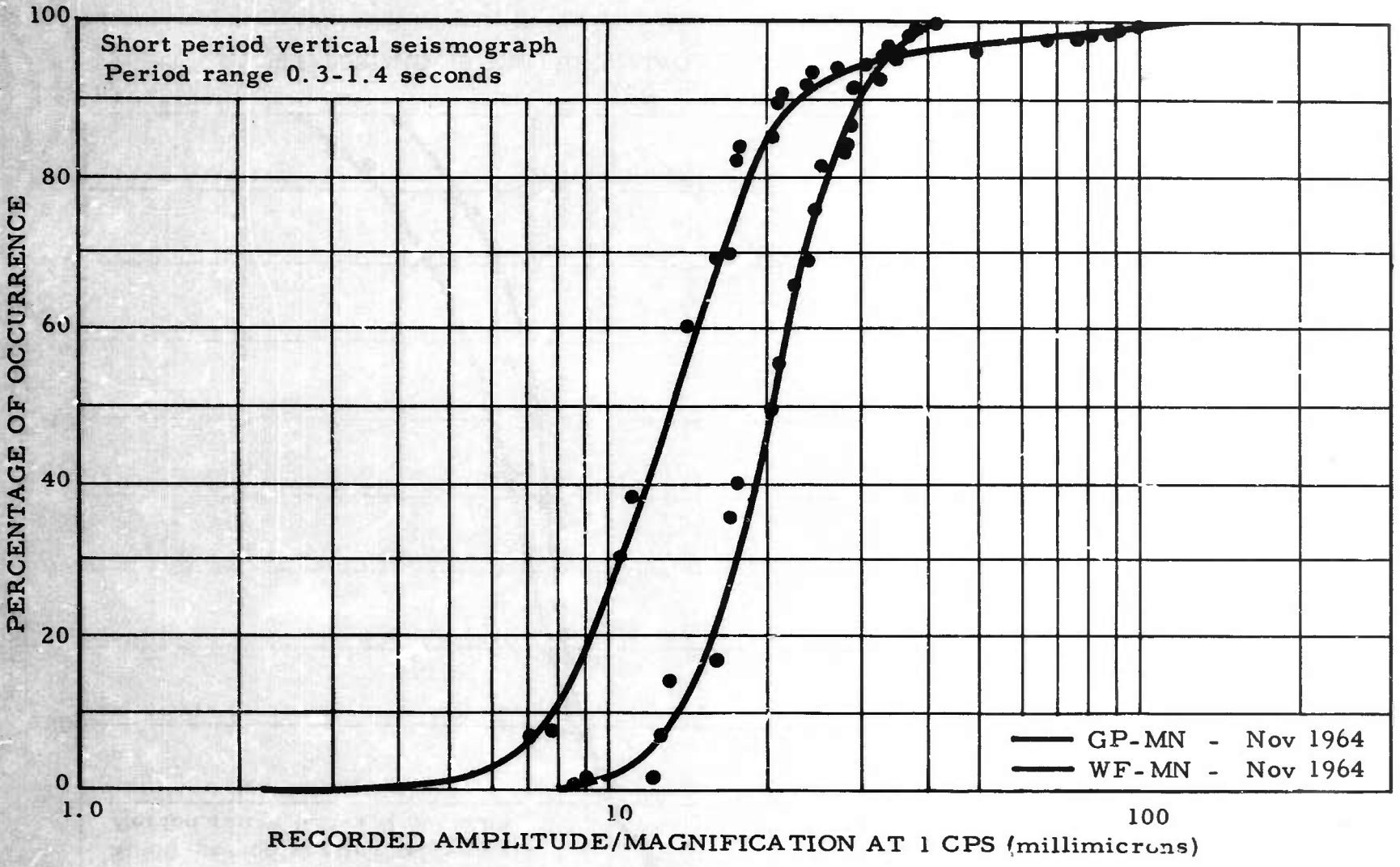
Cumulative probability distribution of amplitude, standard LRSM survey



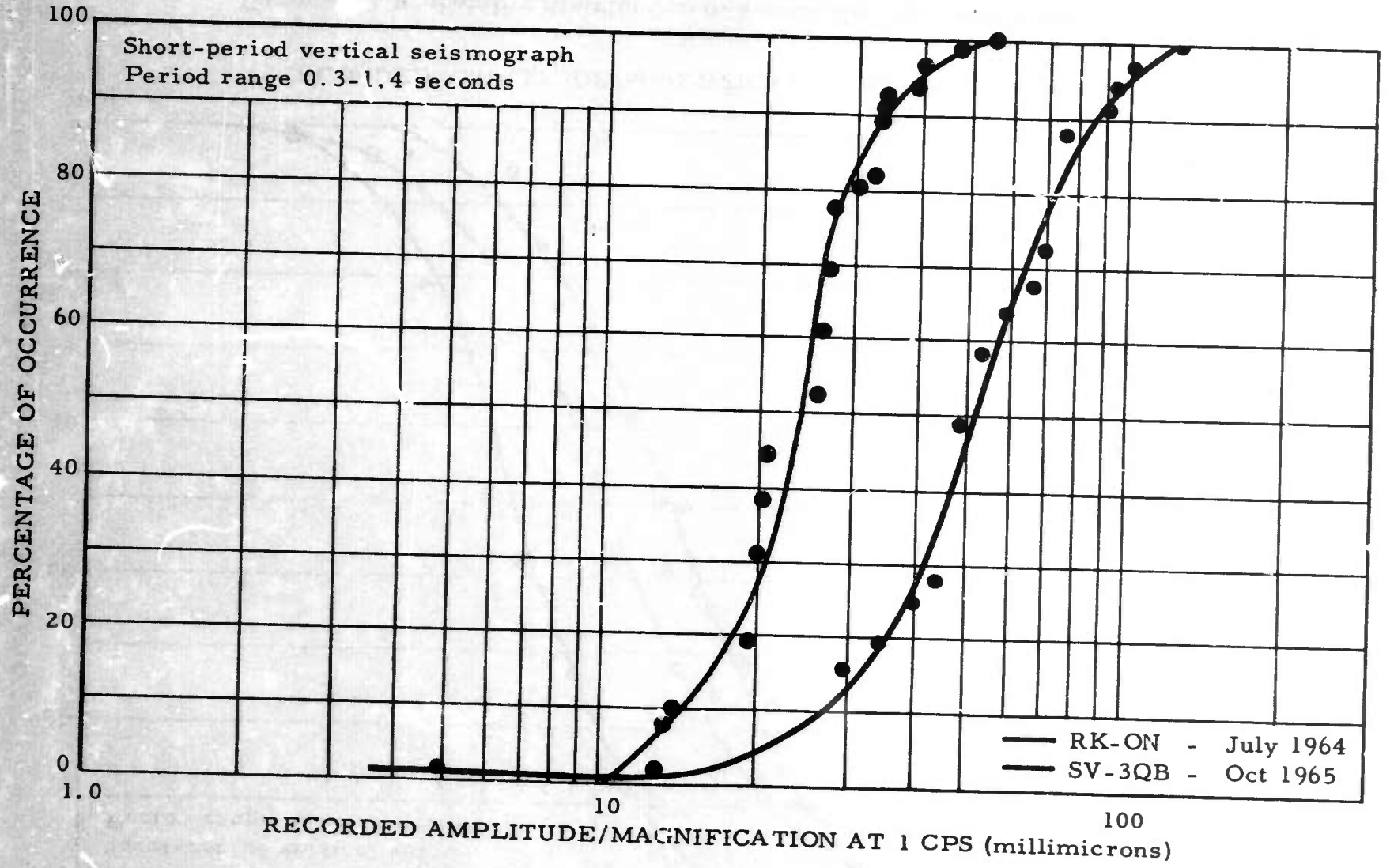
Cumulative probability distribution of amplitude, standard LRSM survey



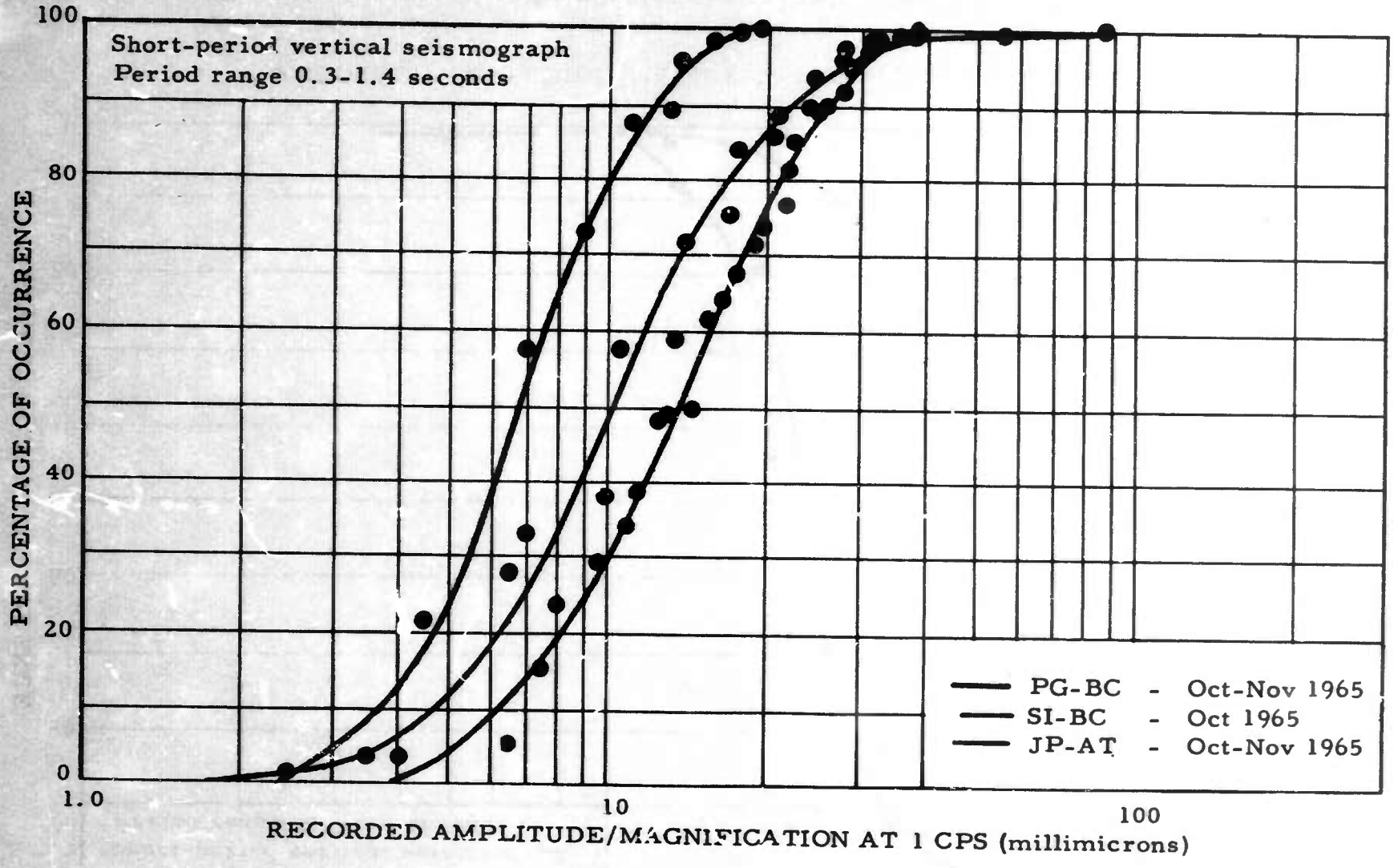
Cumulative probability distribution of amplitude, standard LRSM survey



Cumulative probability distribution of amplitude, standard LRSM survey



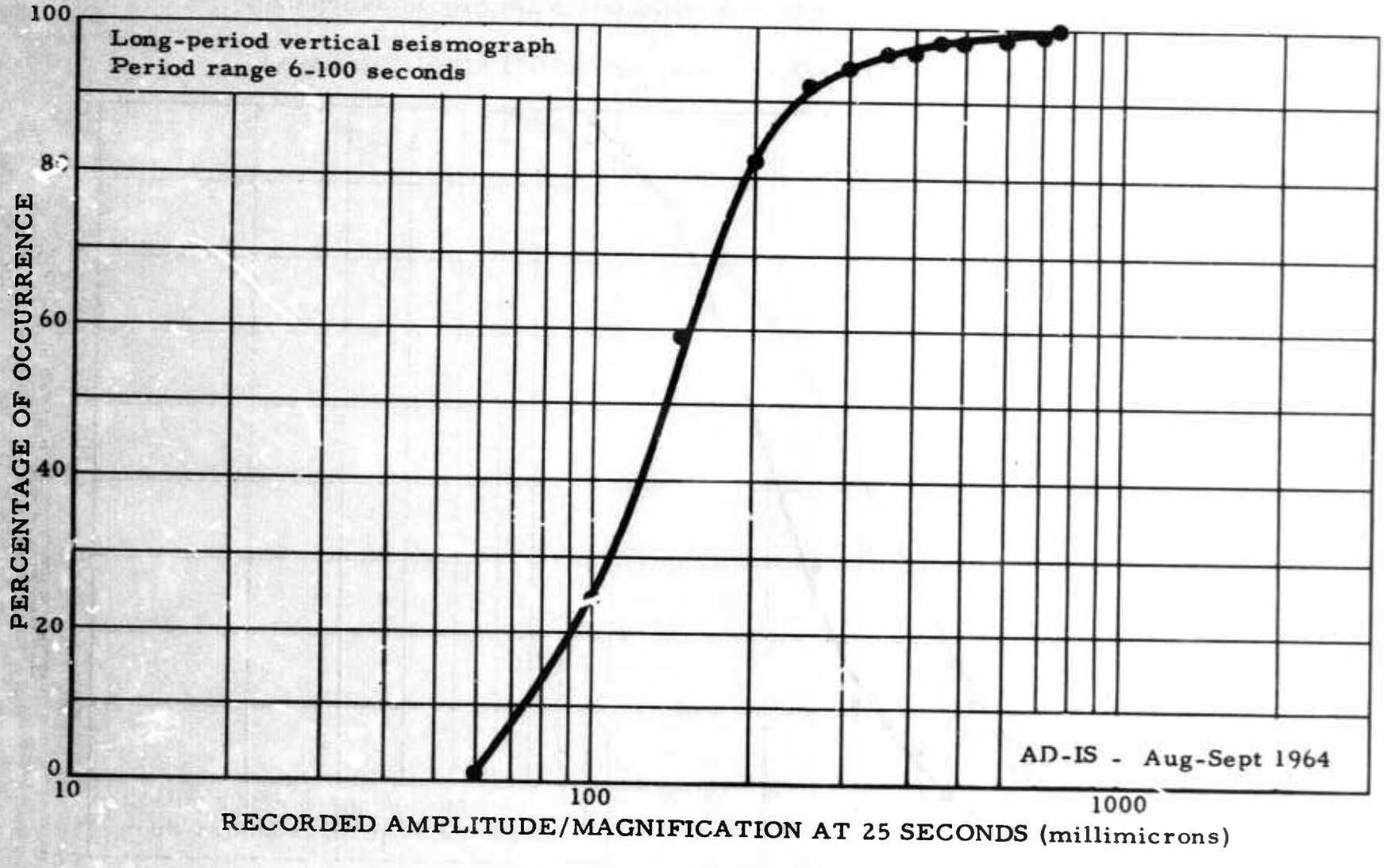
Cumulative probability distribution of amplitude, standard LRSM survey



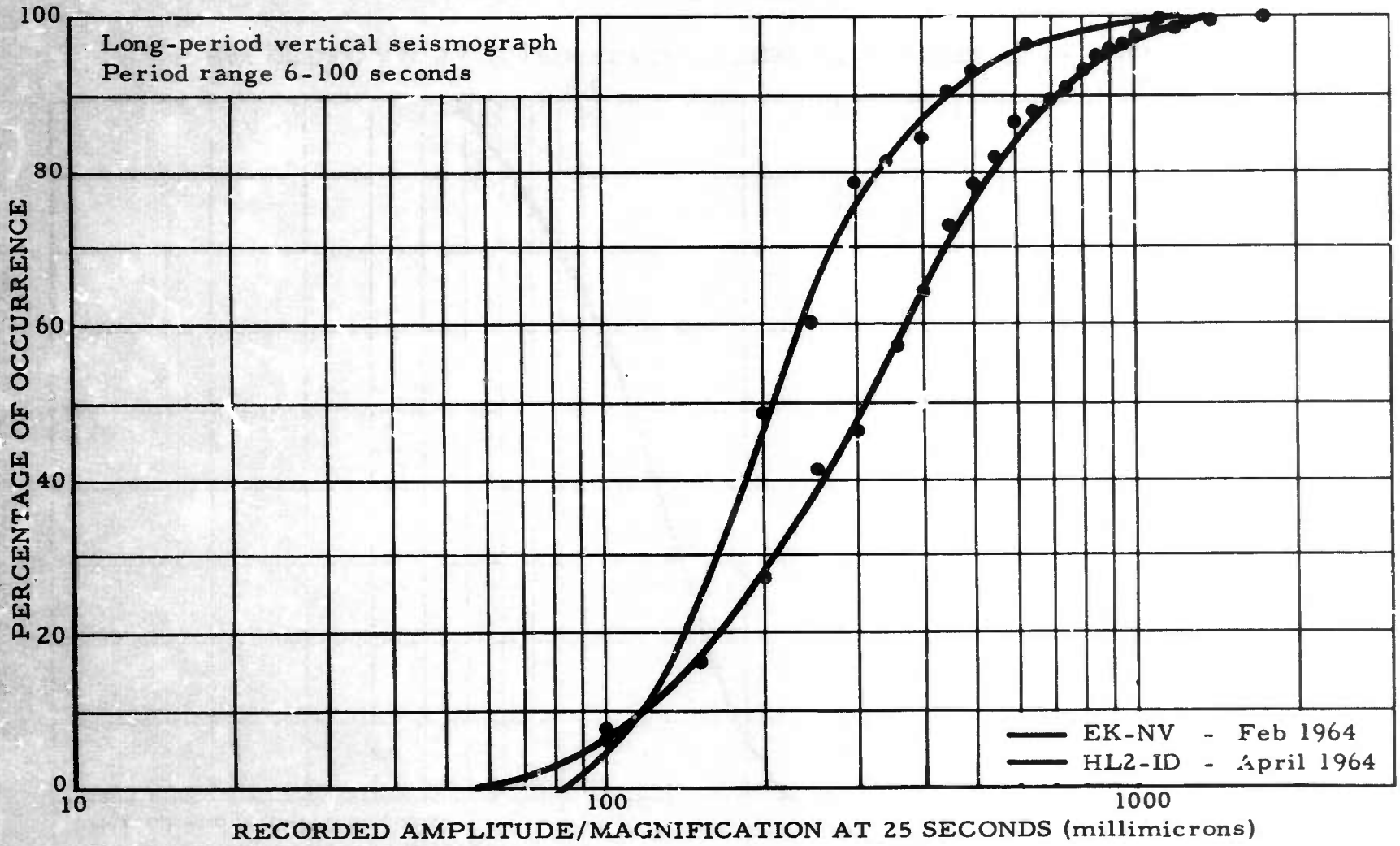
Cumulative probability distribution of amplitude, standard LRSM survey

APPENDIX 2 to TECHNICAL REPORT NO. 67-19

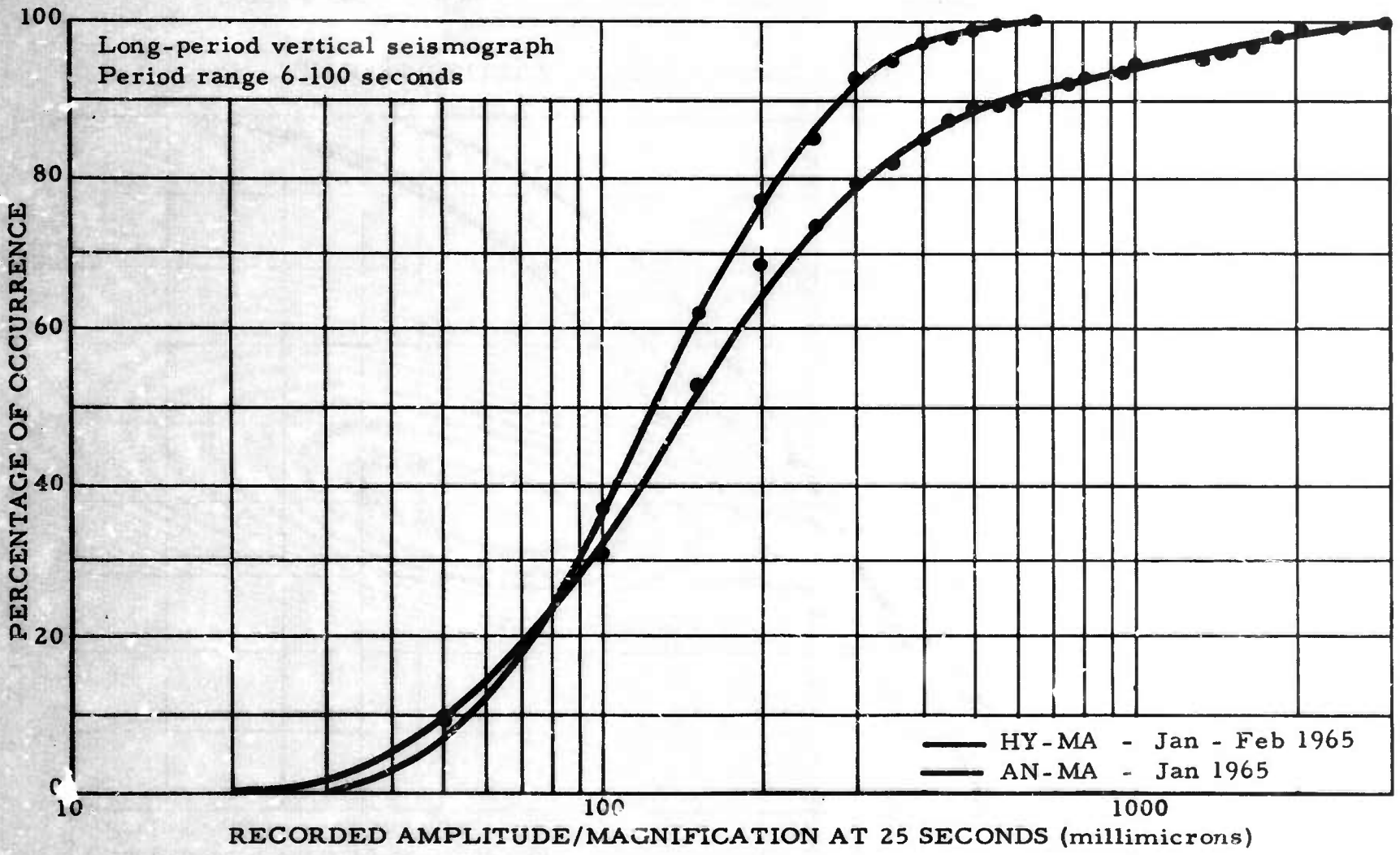
LONG-PERIOD NOISE OCCURRENCE CURVES



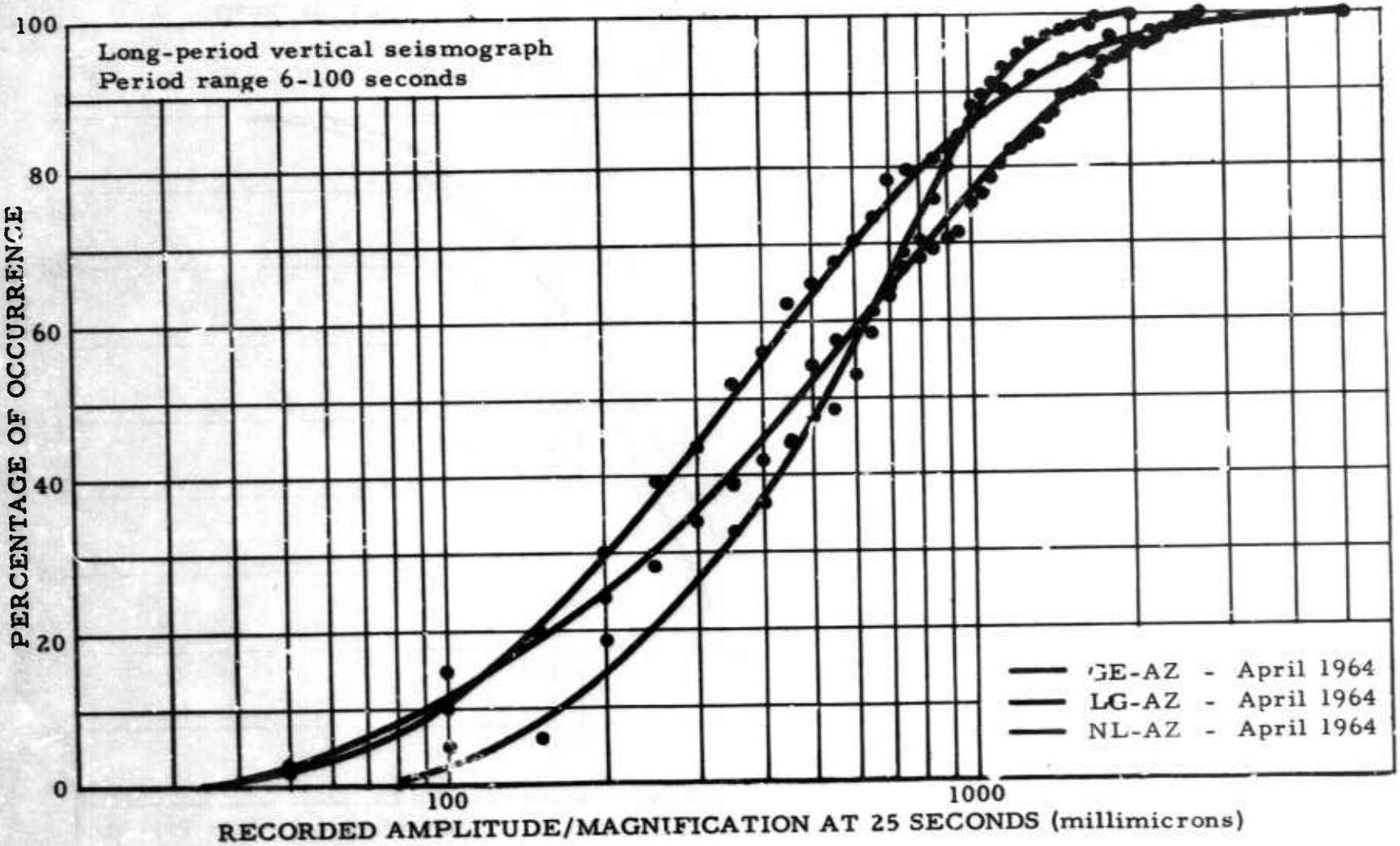
Cumulative probability distribution of amplitude, standard LRSM survey



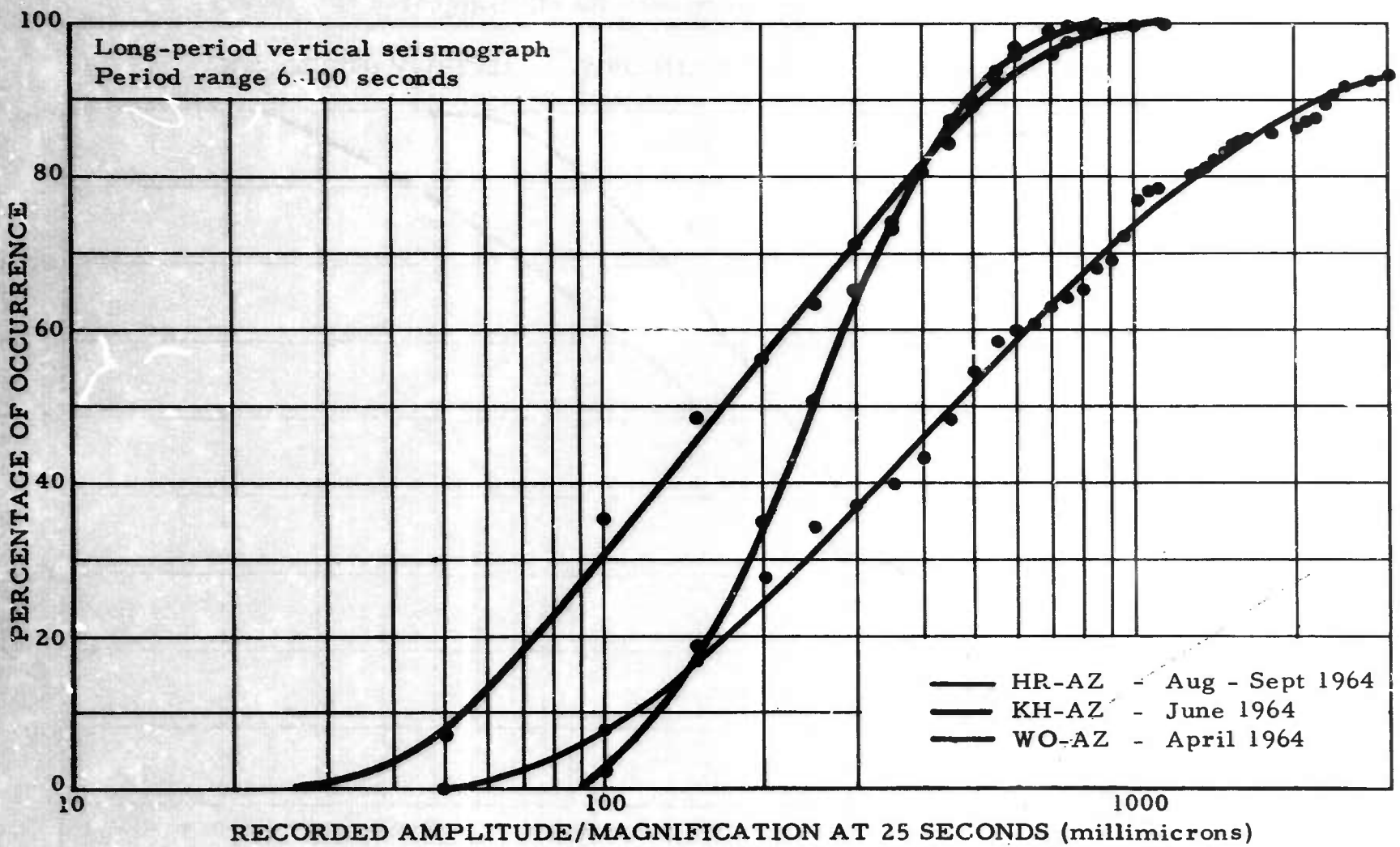
Cumulative probability distribution of amplitude, standard LRSM survey



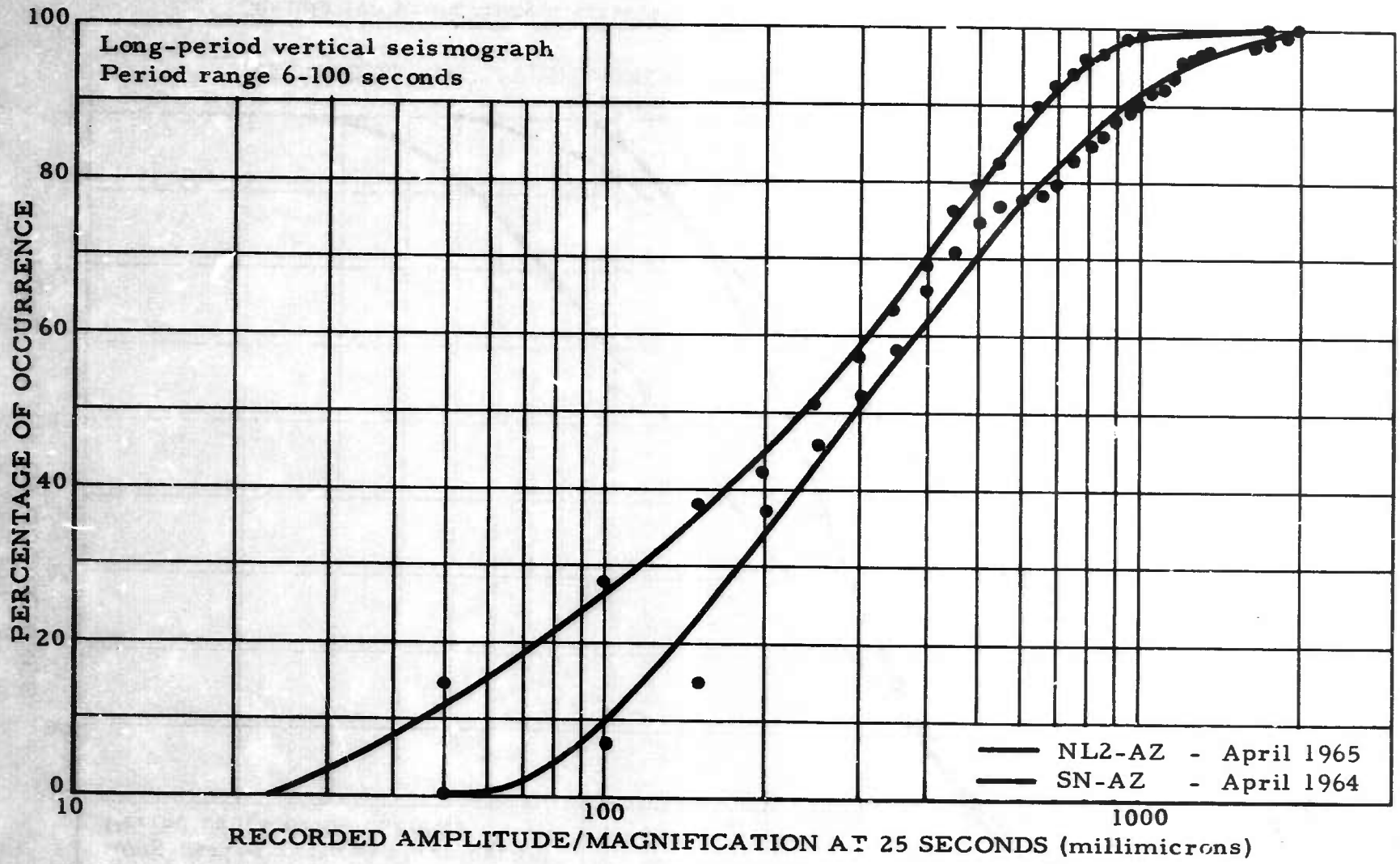
Cumulative probability distribution of amplitude, standard LRSM survey



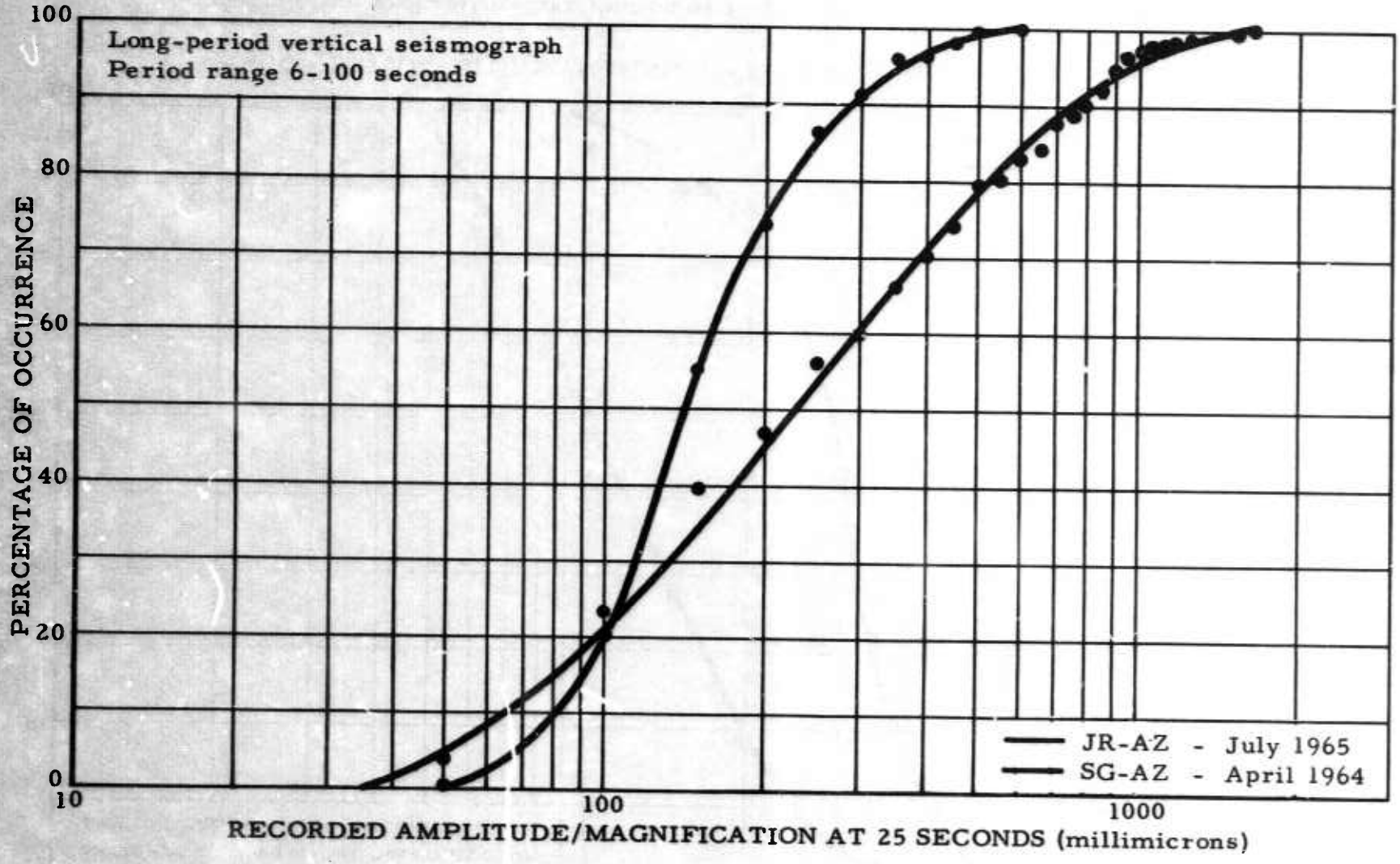
Cumulative probability distribution of amplitude, standard LRSM survey



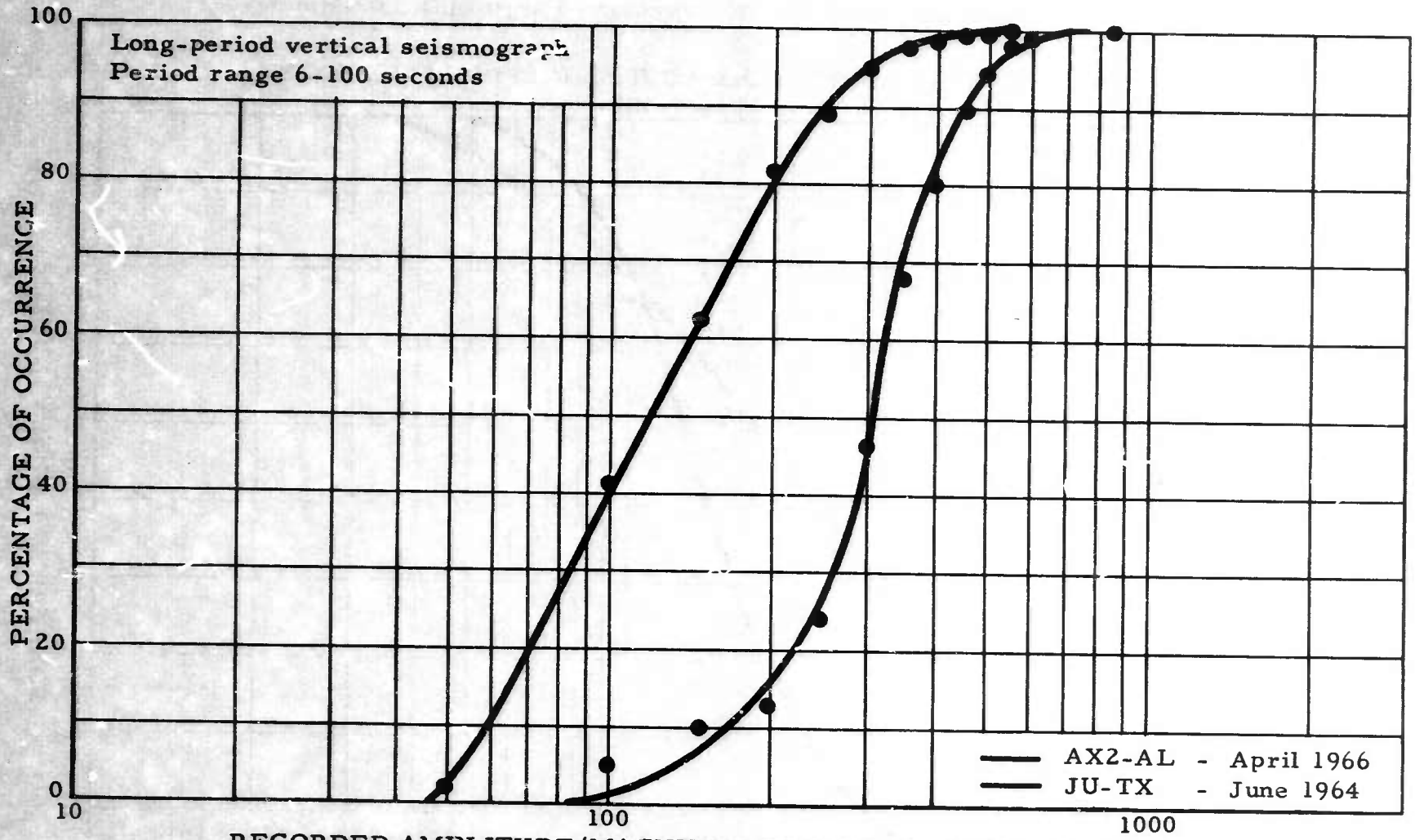
Cumulative probability distribution of amplitude, standard LRSM survey



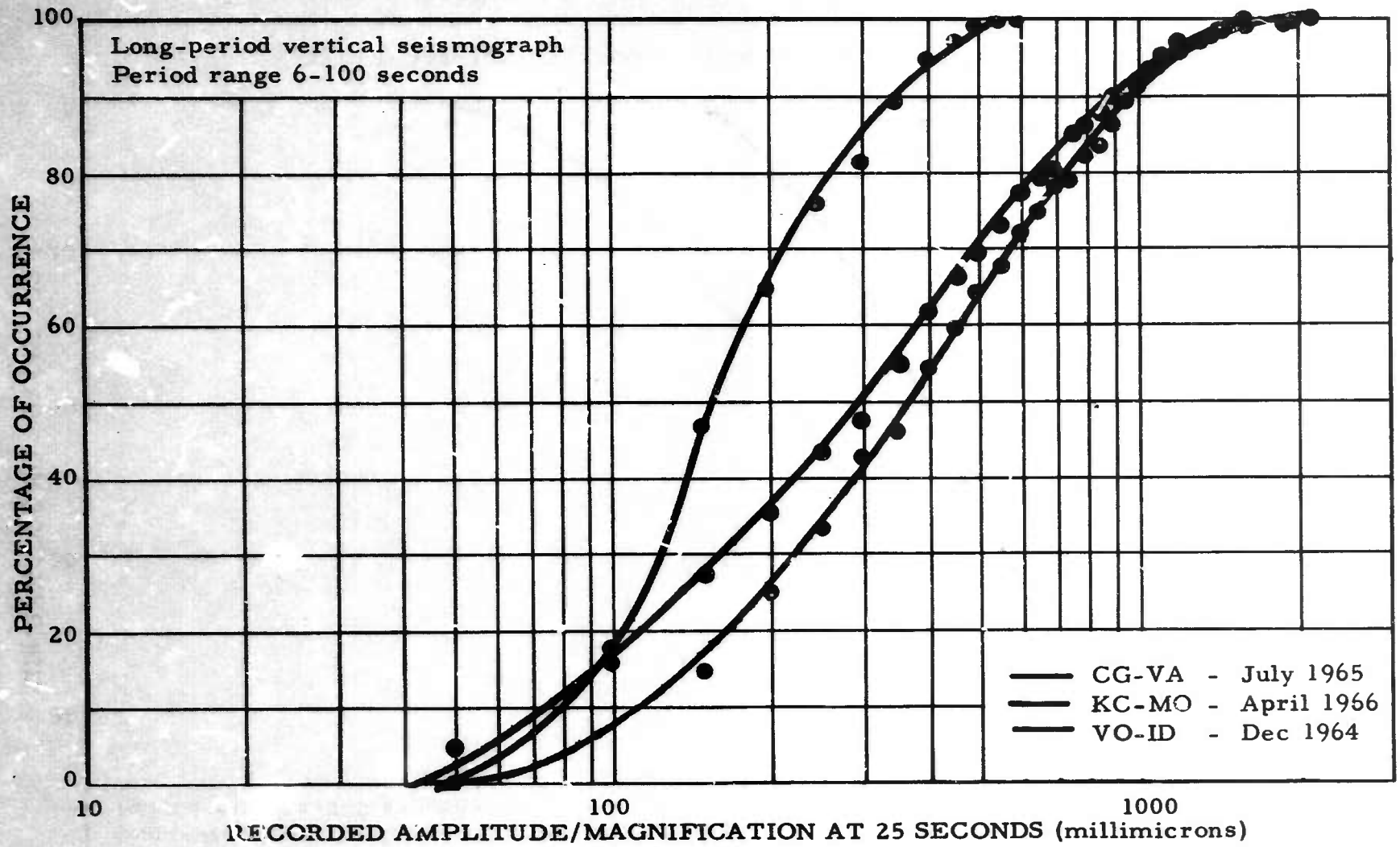
Cumulative probability distribution of amplitude, standard LRSM survey



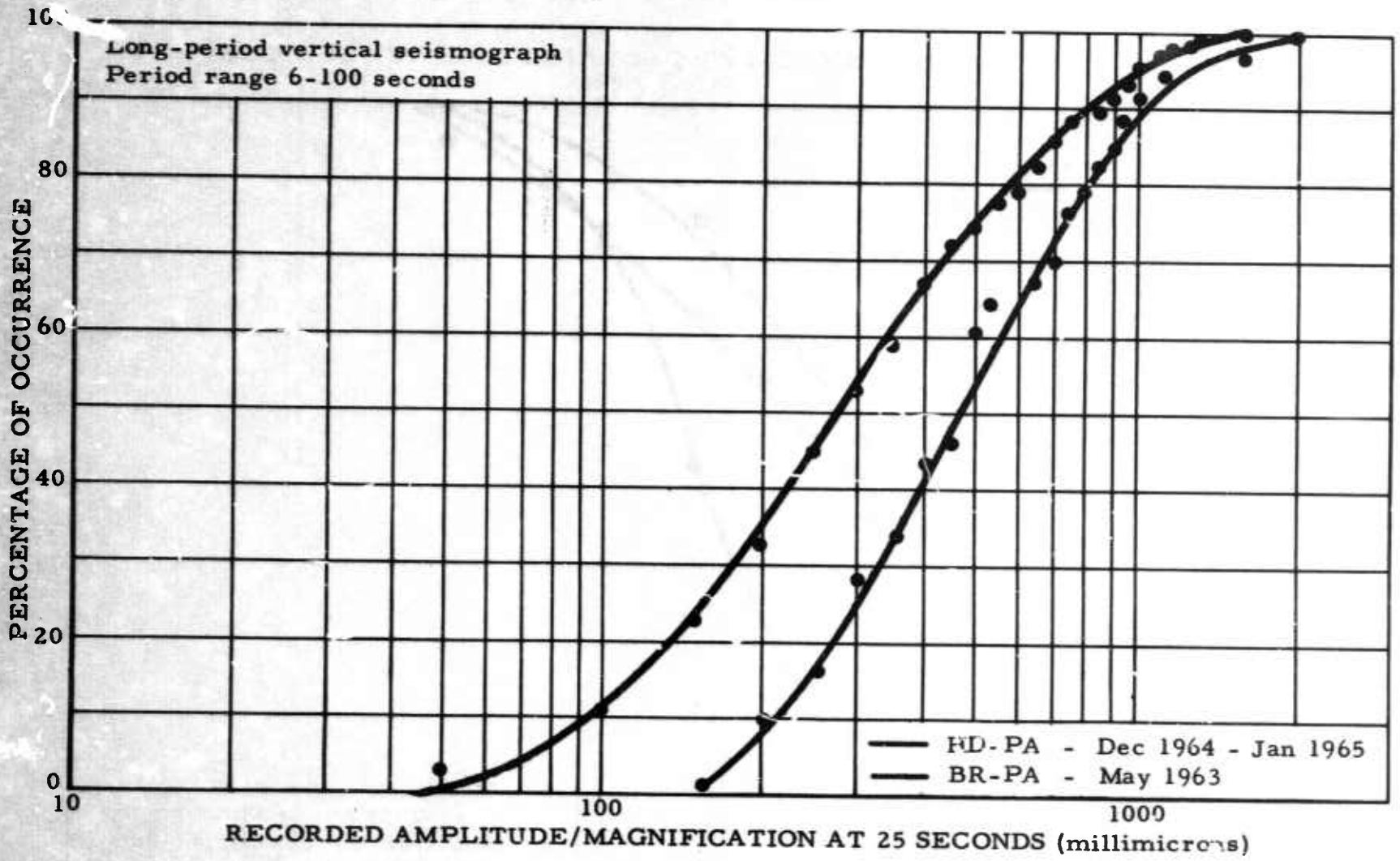
Cumulative probability distribution of amplitude, standard LRSM survey



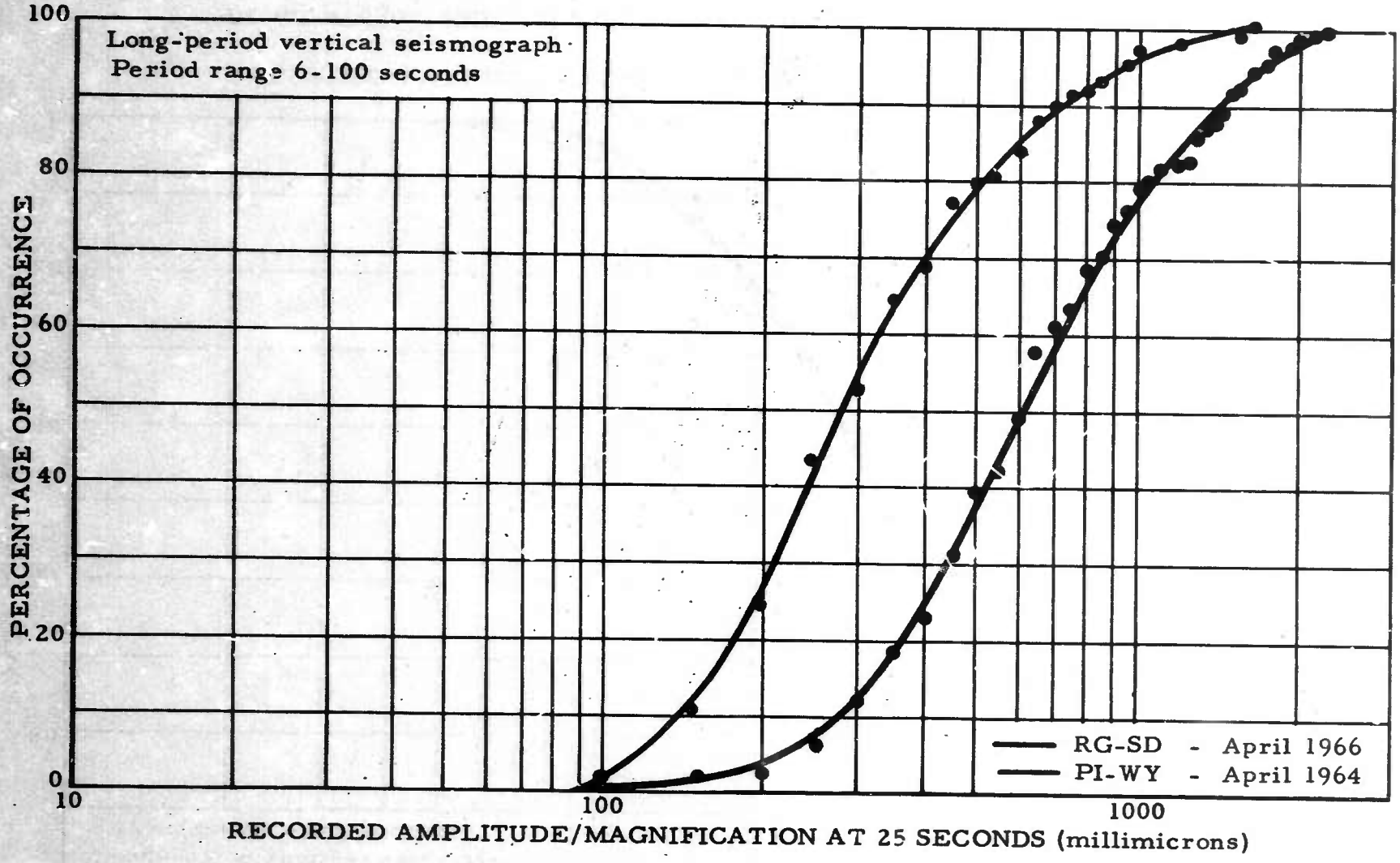
Cumulative probability distribution of amplitude, standard LRSM survey



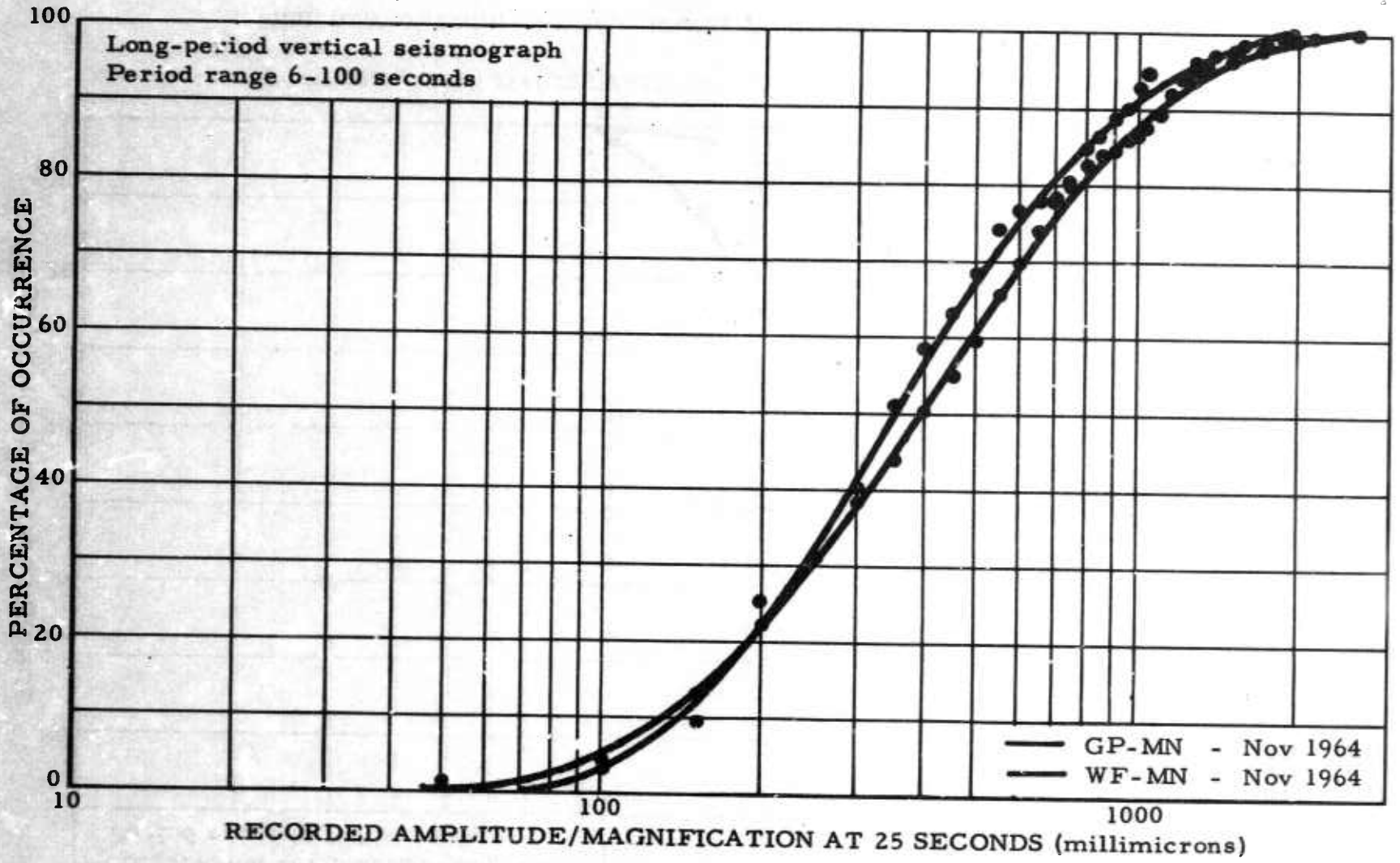
Cumulative probability distribution of amplitude, standard LRSM survey



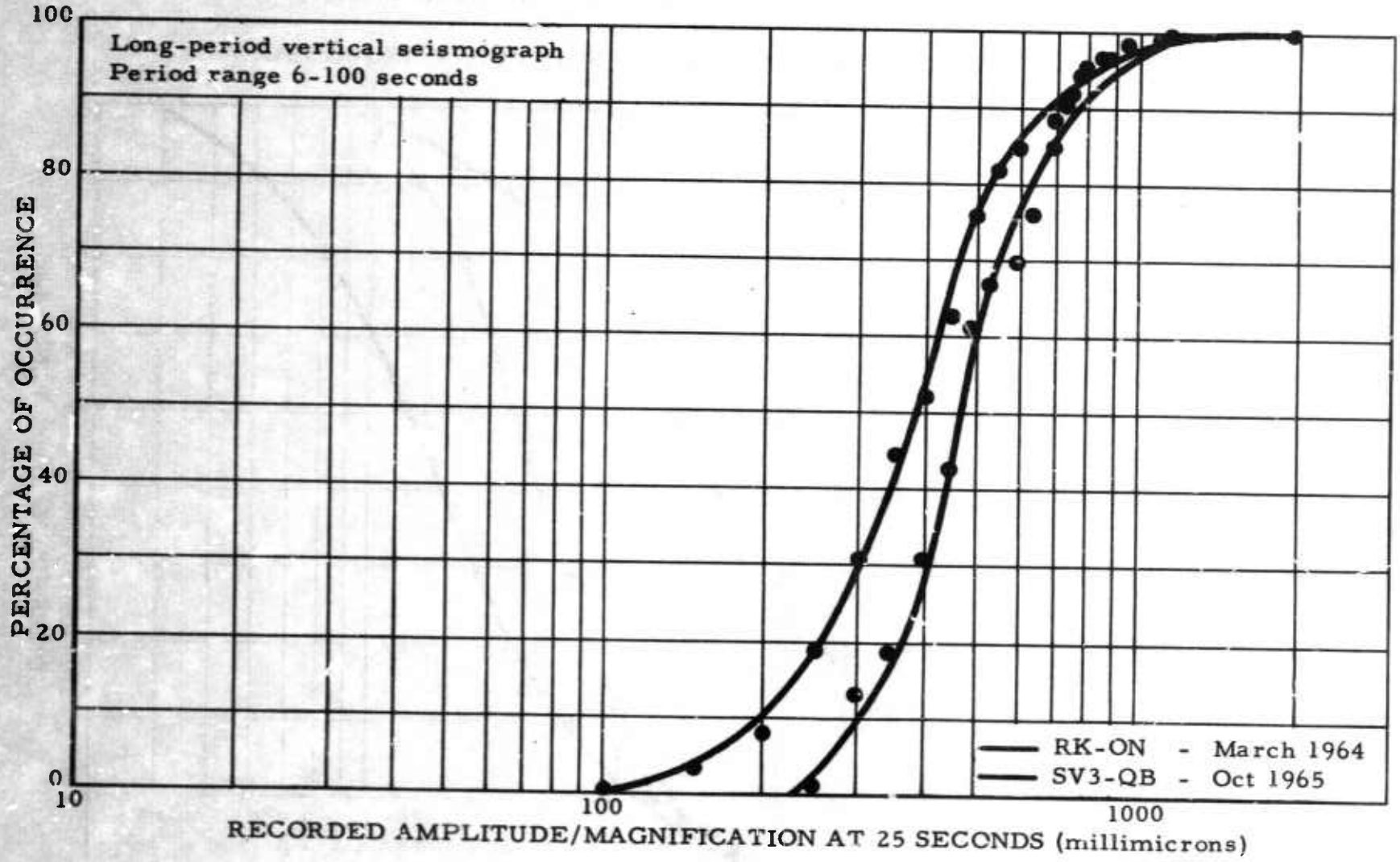
Cumulative probability distribution of amplitude, standard LRSM survey



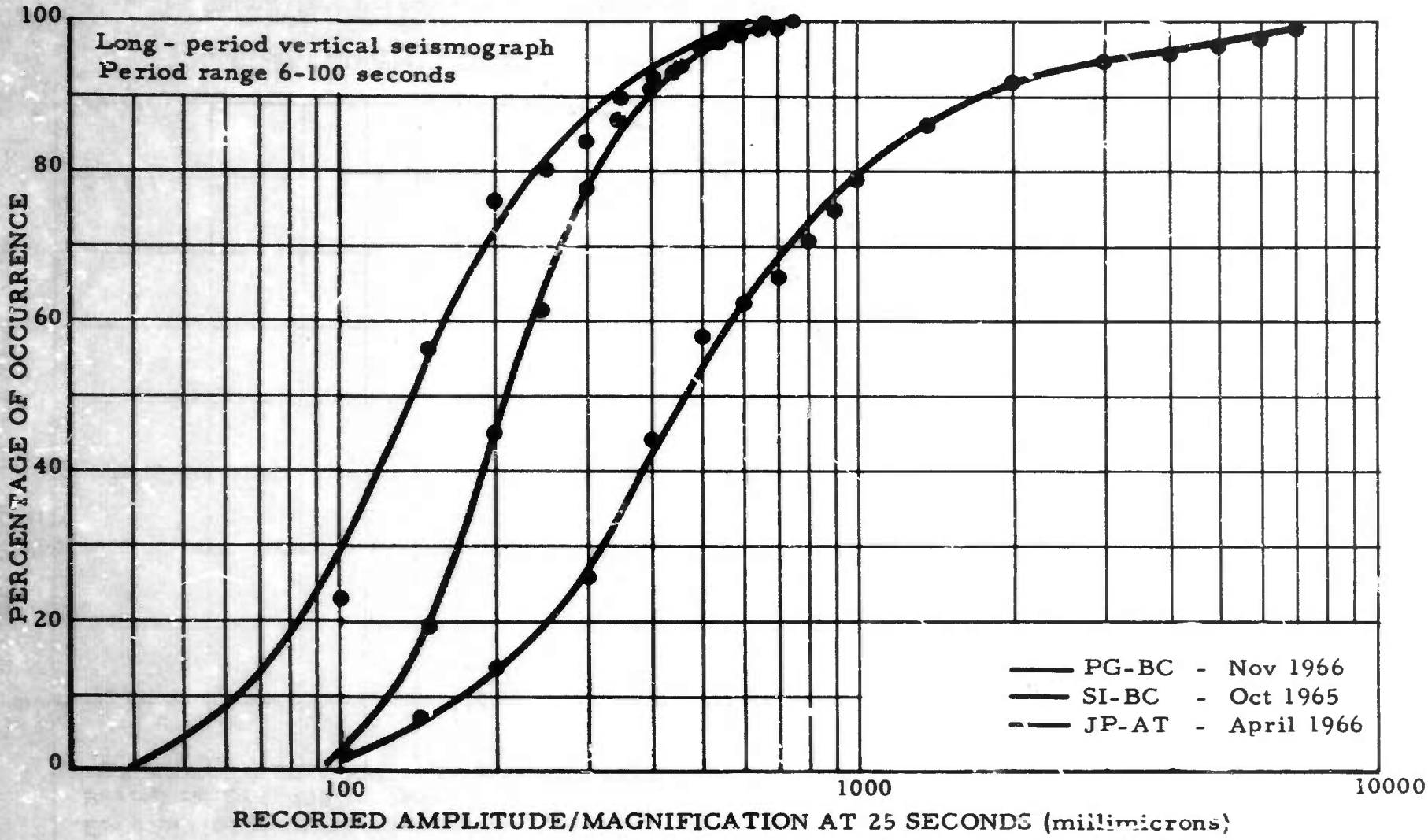
Cumulative probability distribution of amplitude, standard LRSM survey



Cumulative probability distribution of amplitude, standard LRSM survey



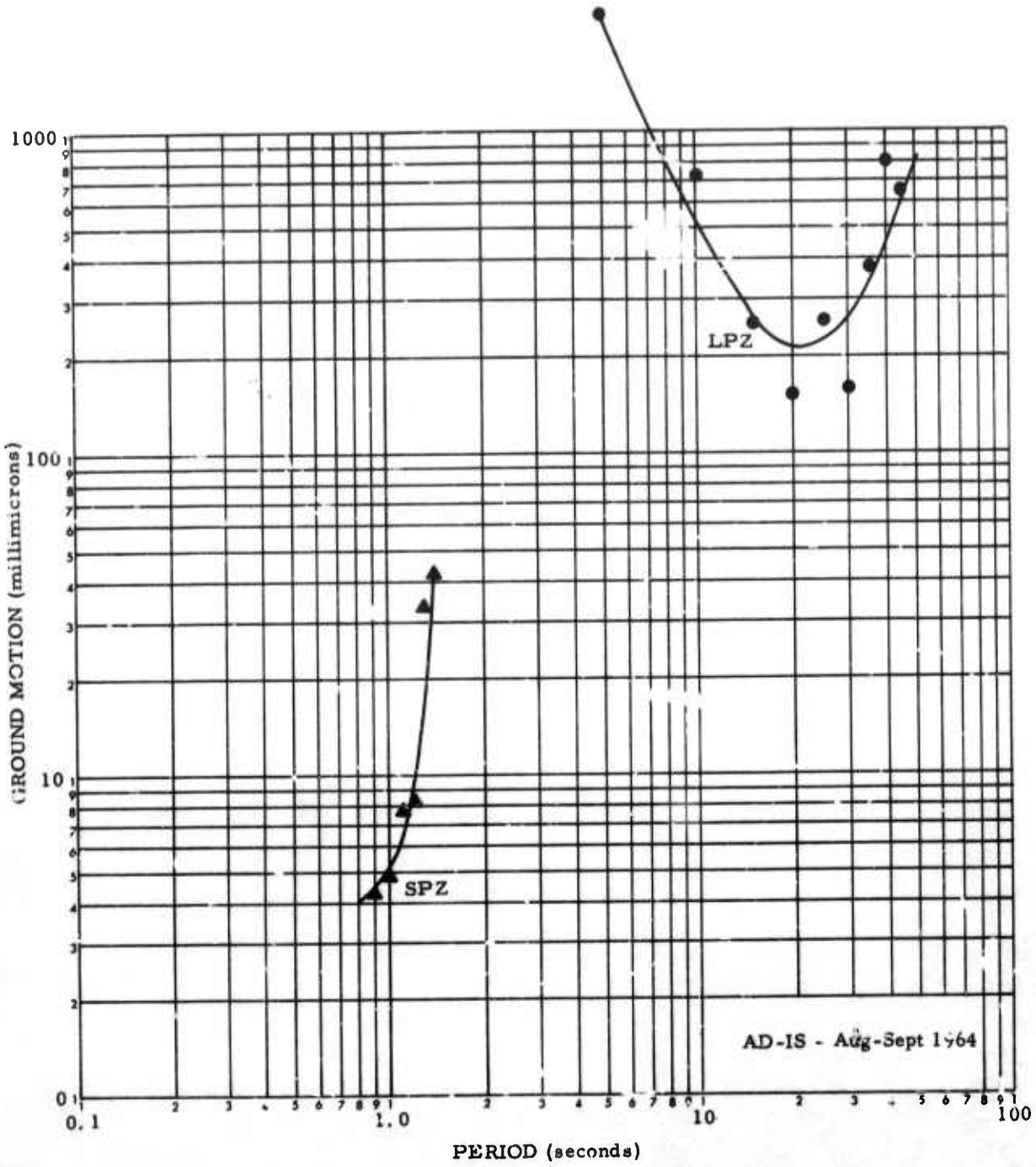
Cumulative probability distribution of amplitude, standard LRSM survey



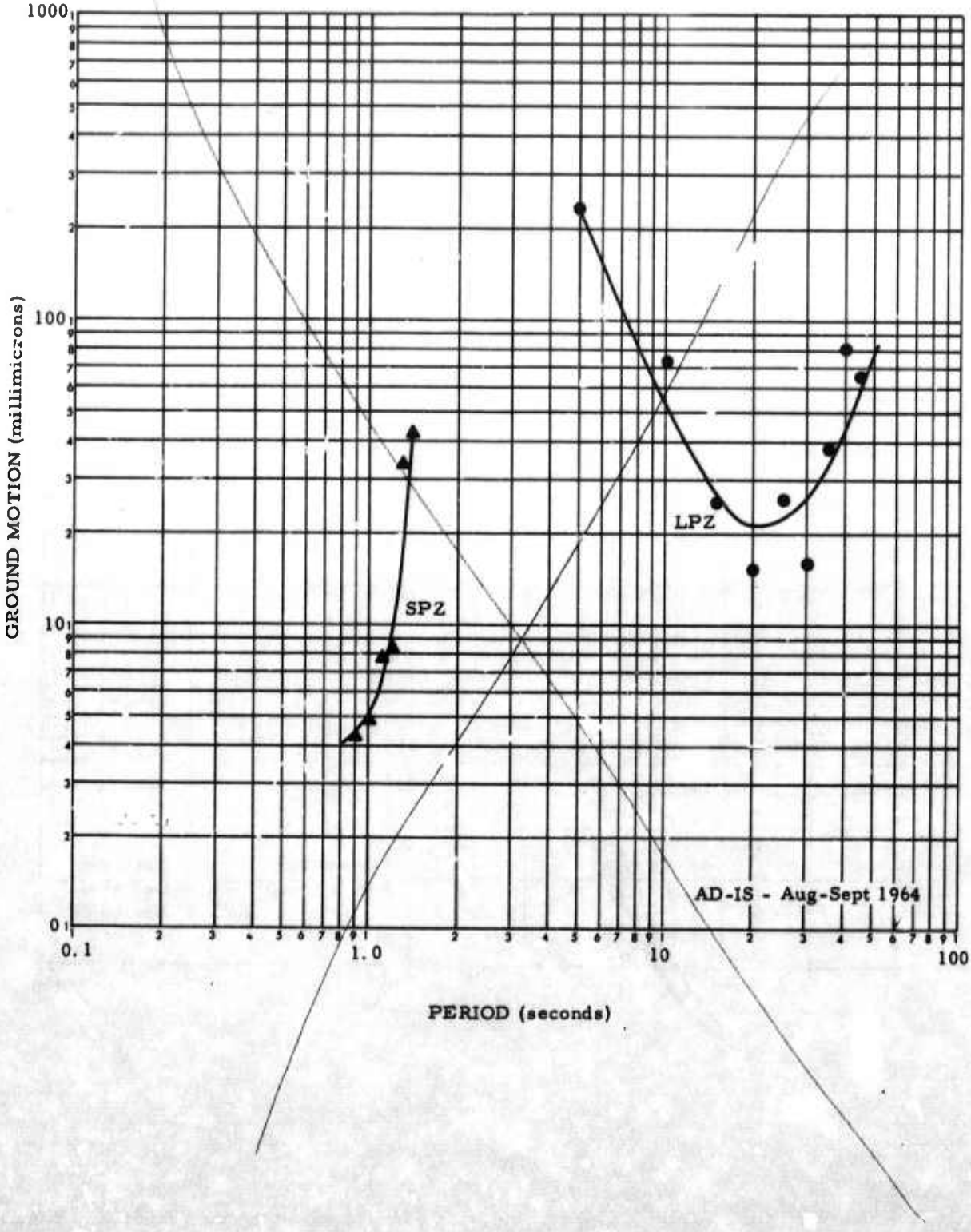
Cumulative probability distribution of amplitude, standard LRSM survey

APPENDIX 3 to TECHNICAL REPORT NO. 67-19

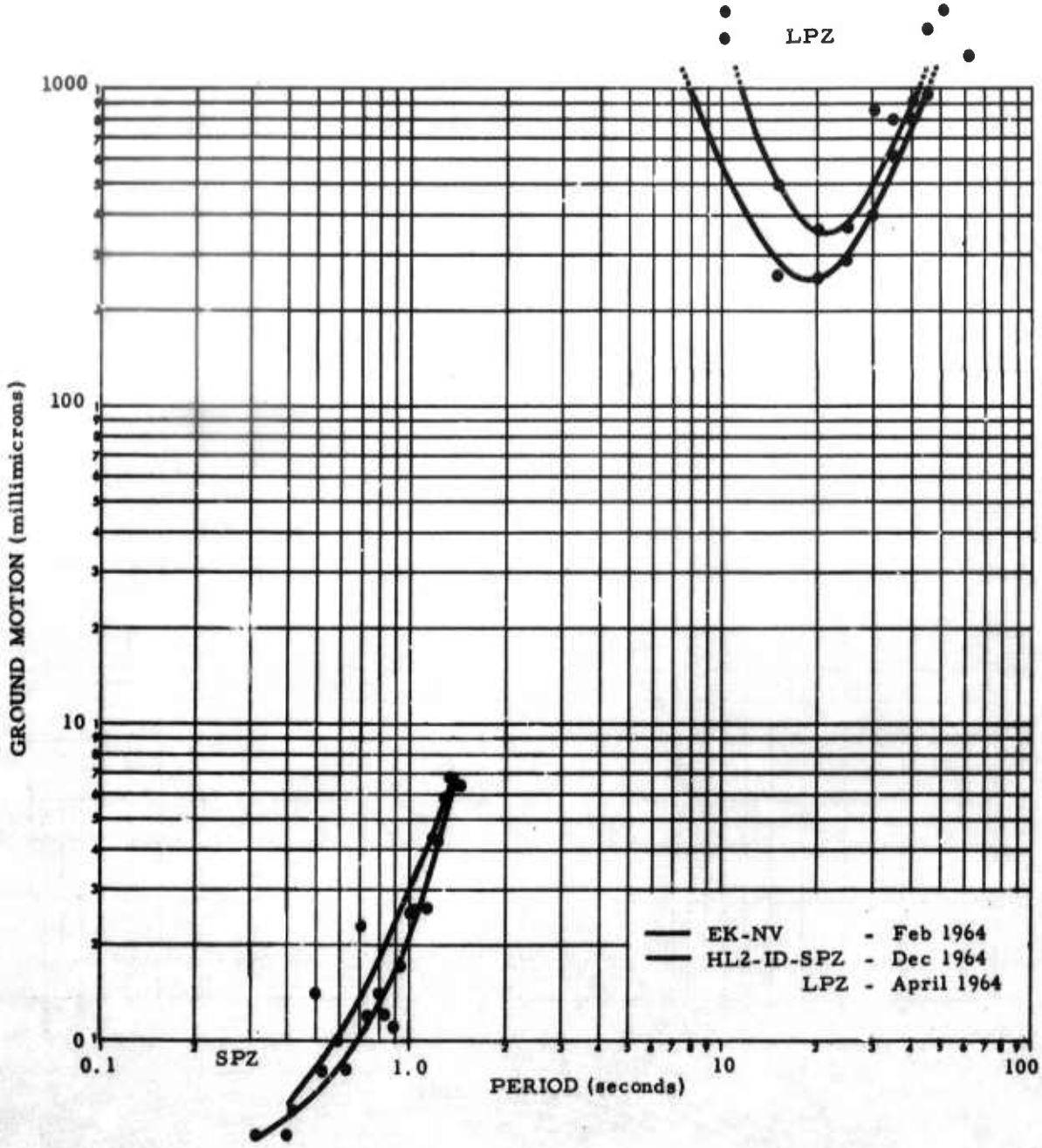
NOISE SPECTRUM CURVES



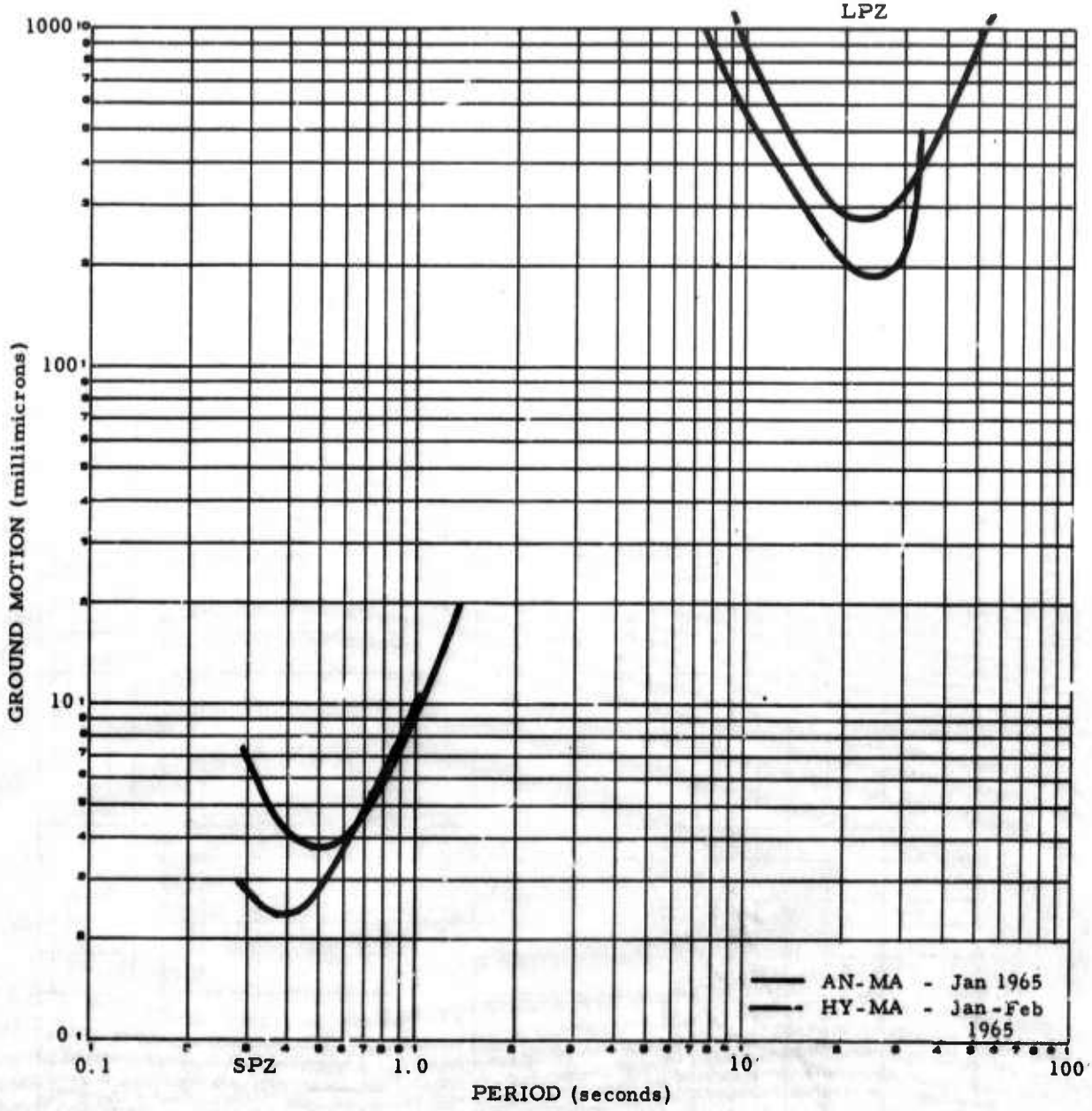
Noise spectrum curve, LRSM



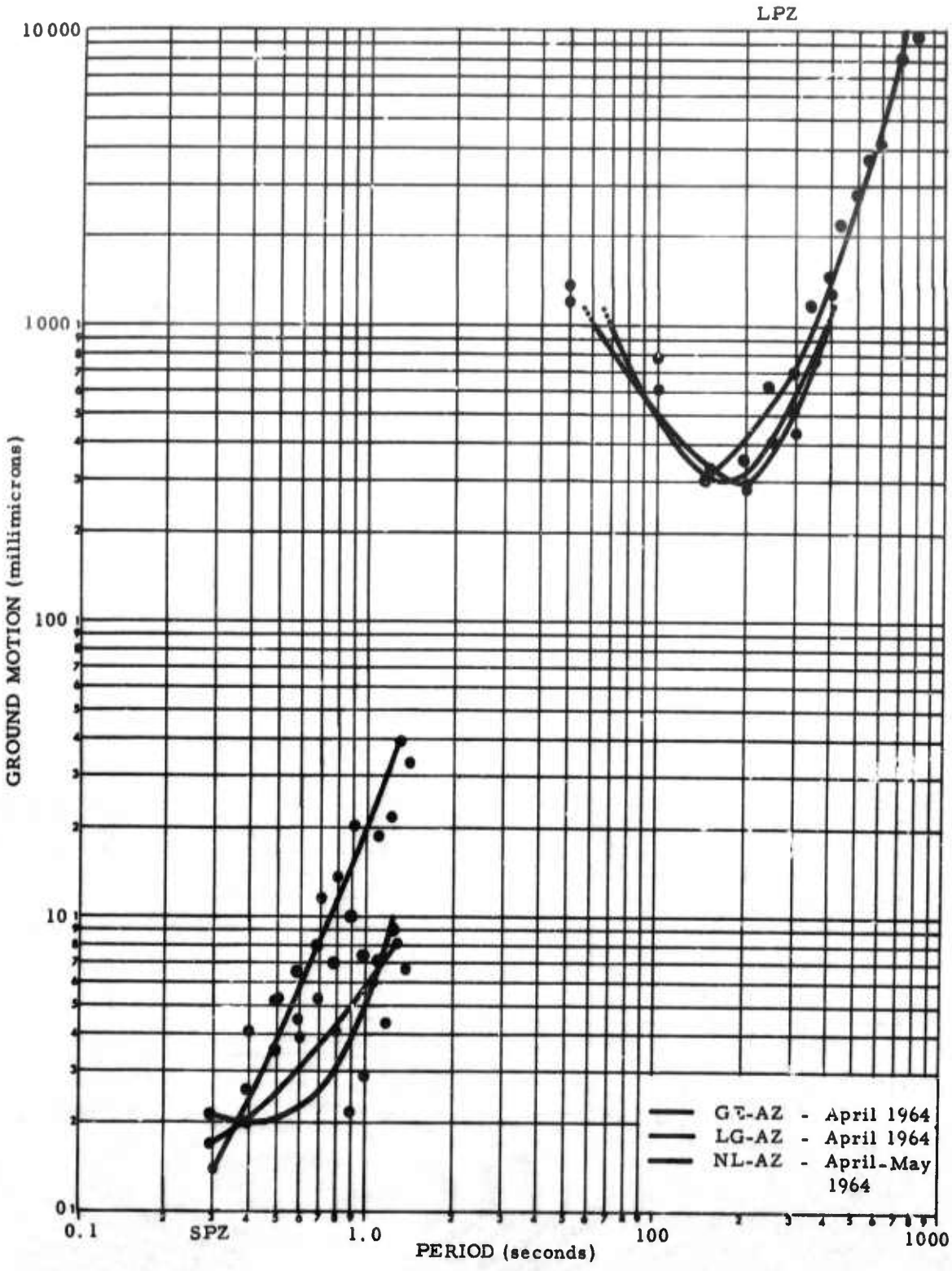
Noise spectrum curve, LRSM



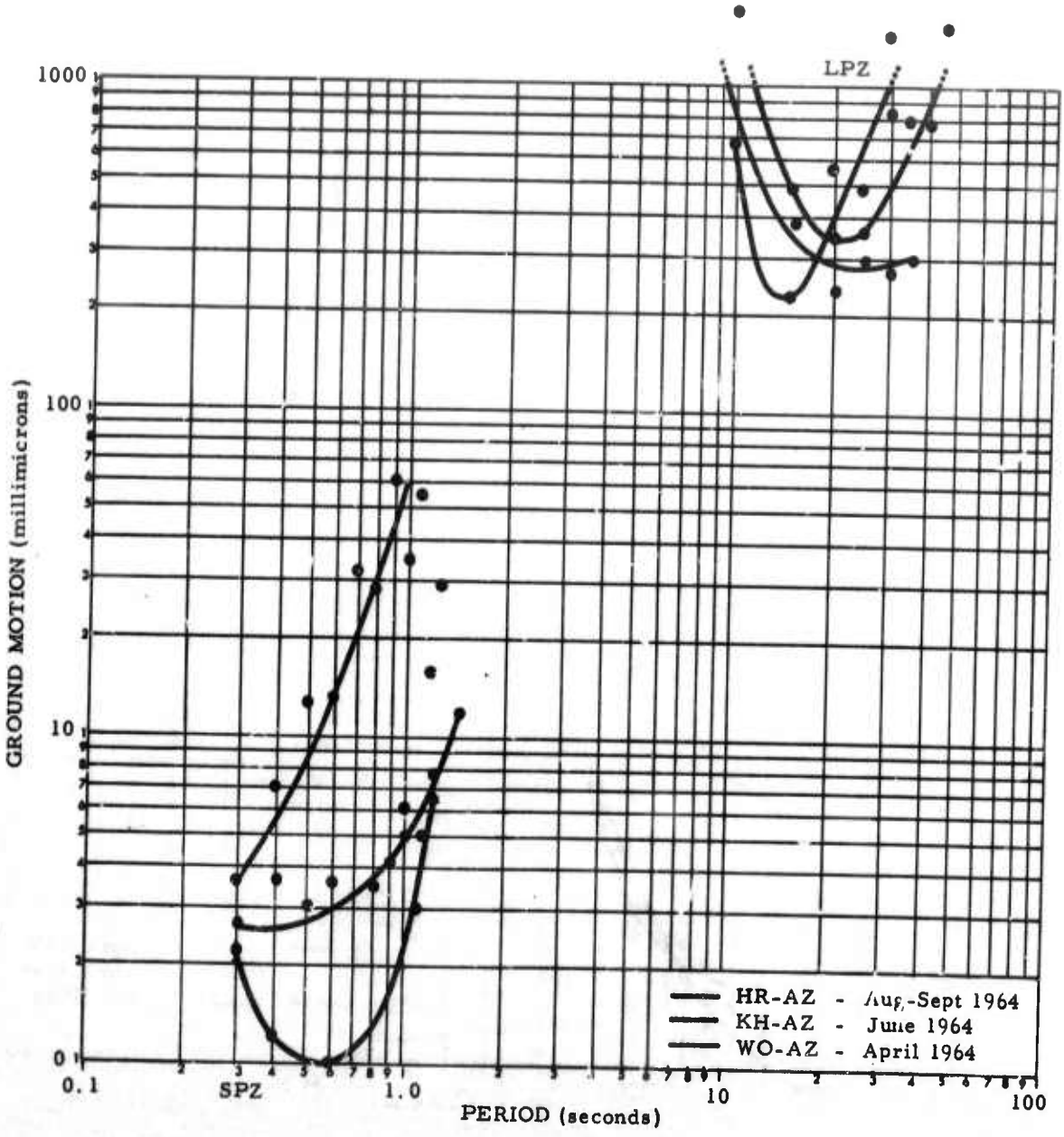
Noise spectrum curve, LRSM



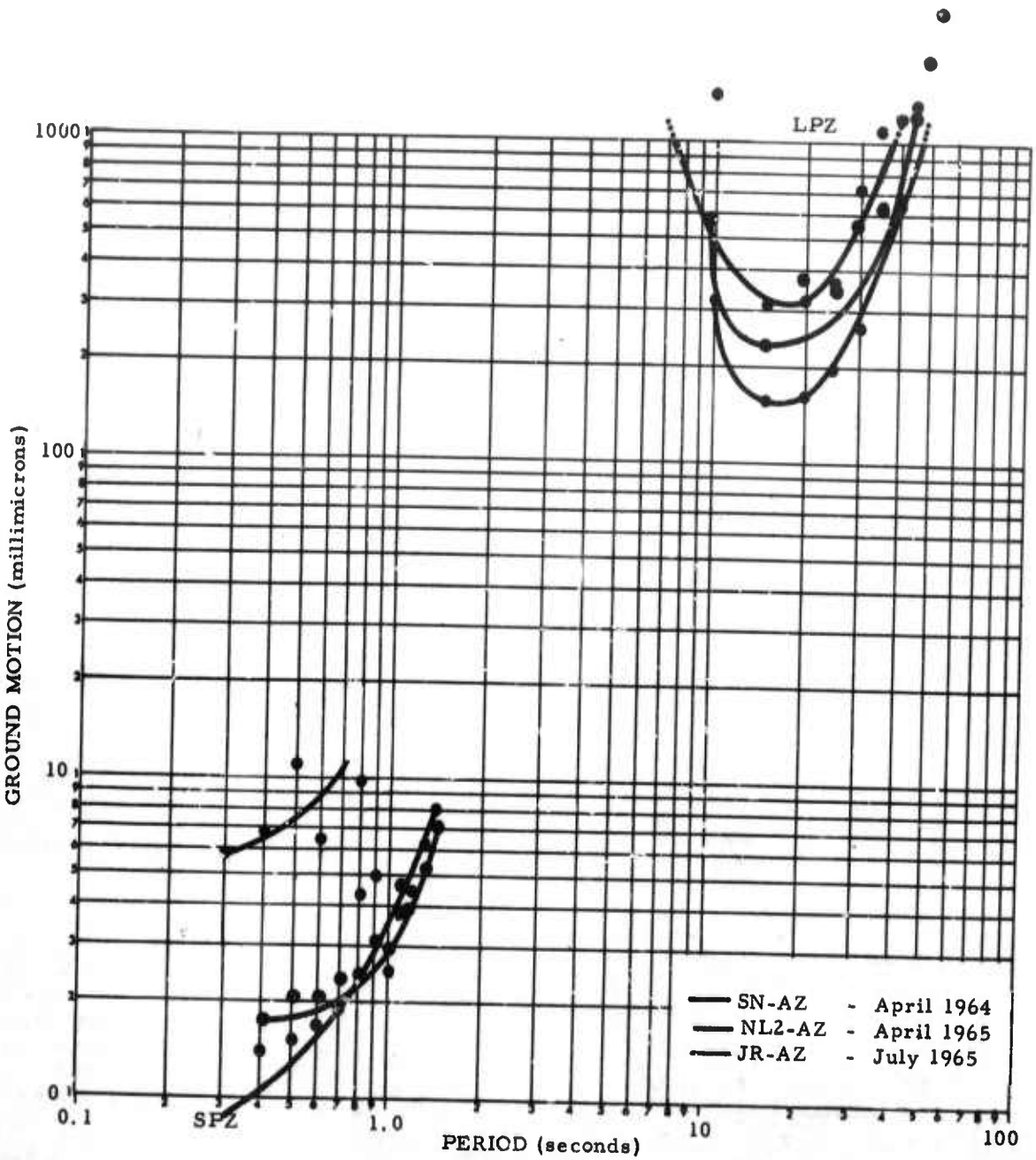
Noise spectrum curve, LRSM



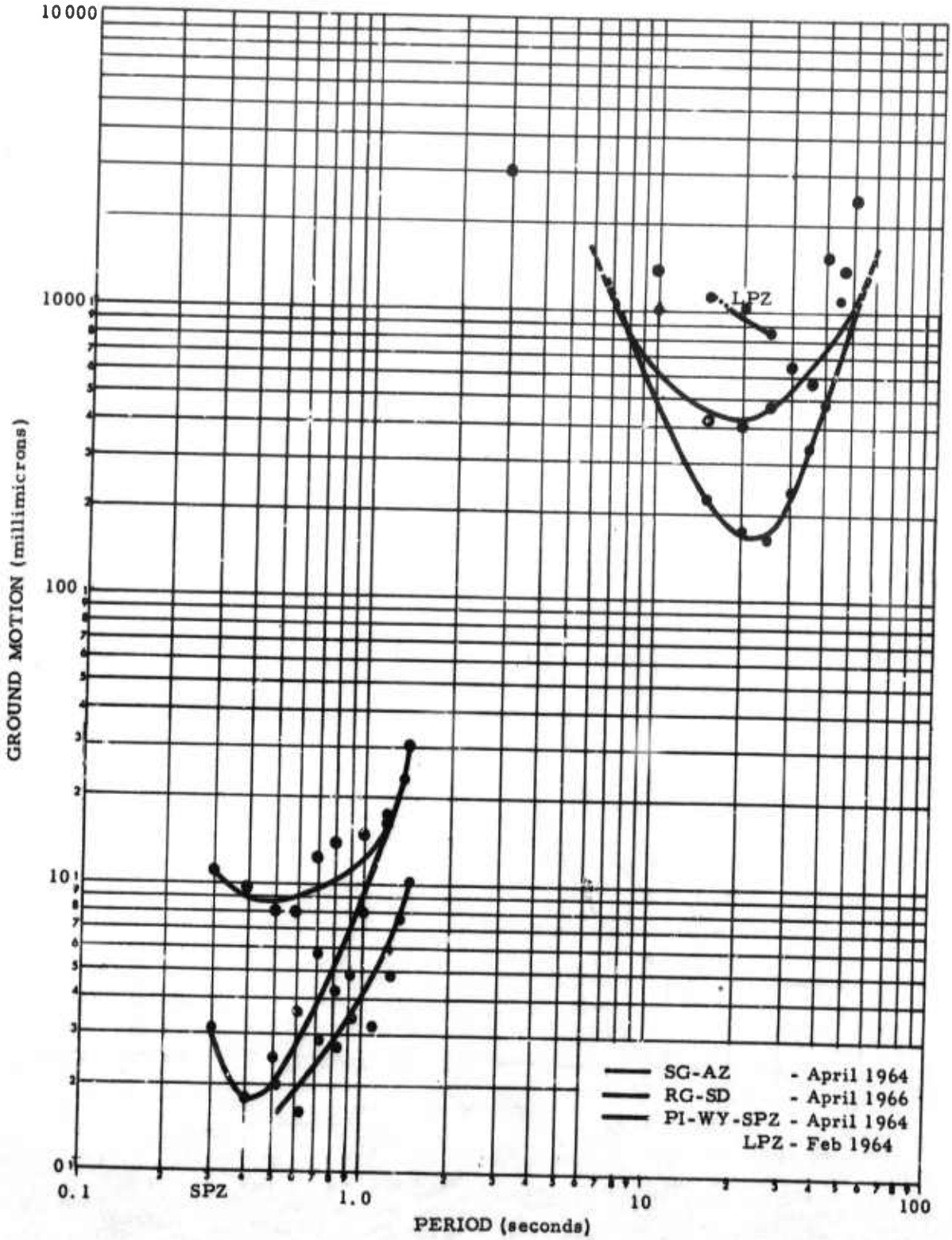
Noise spectrum curve, LRSM



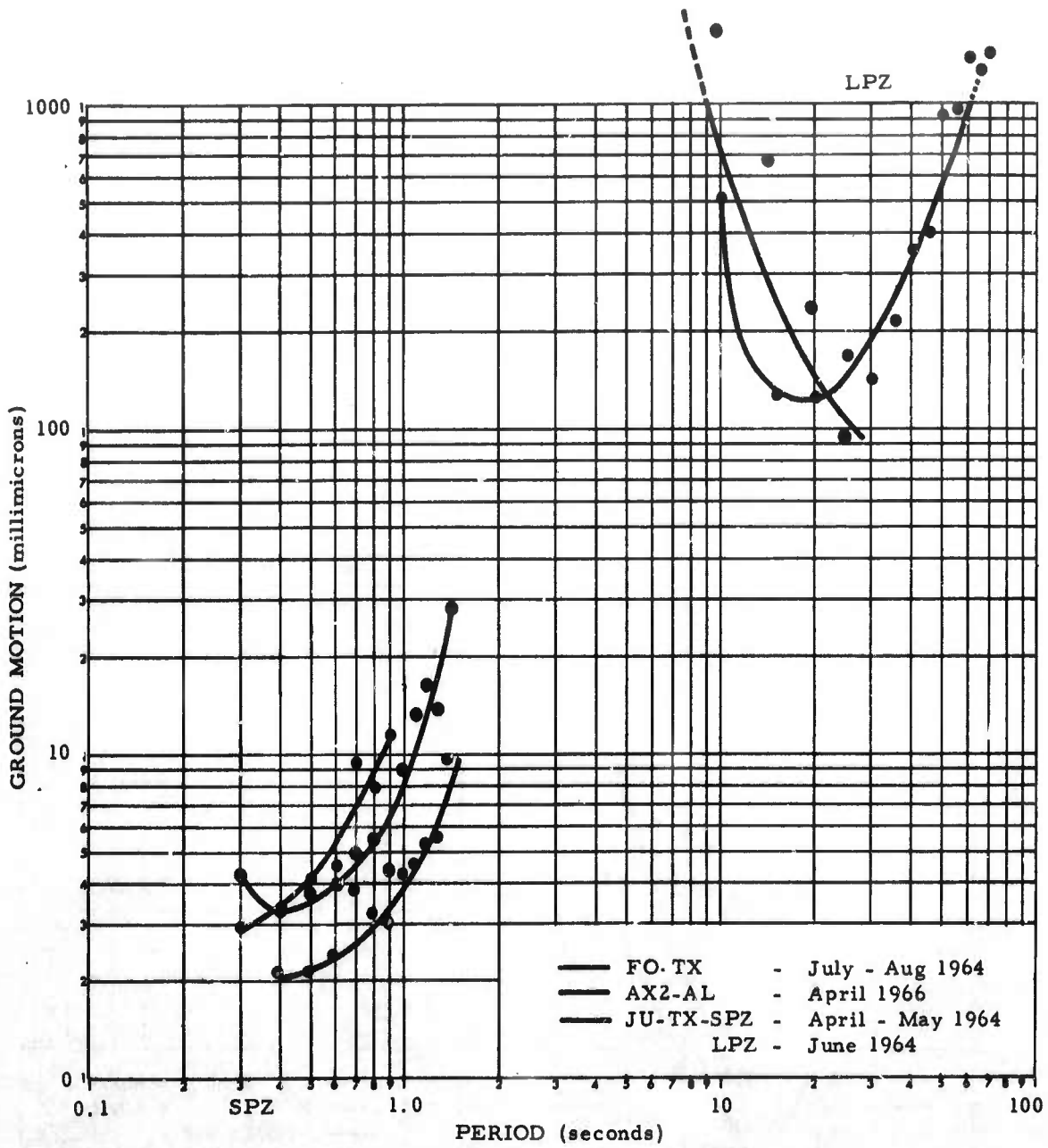
Noise spectrum curve, LRSM



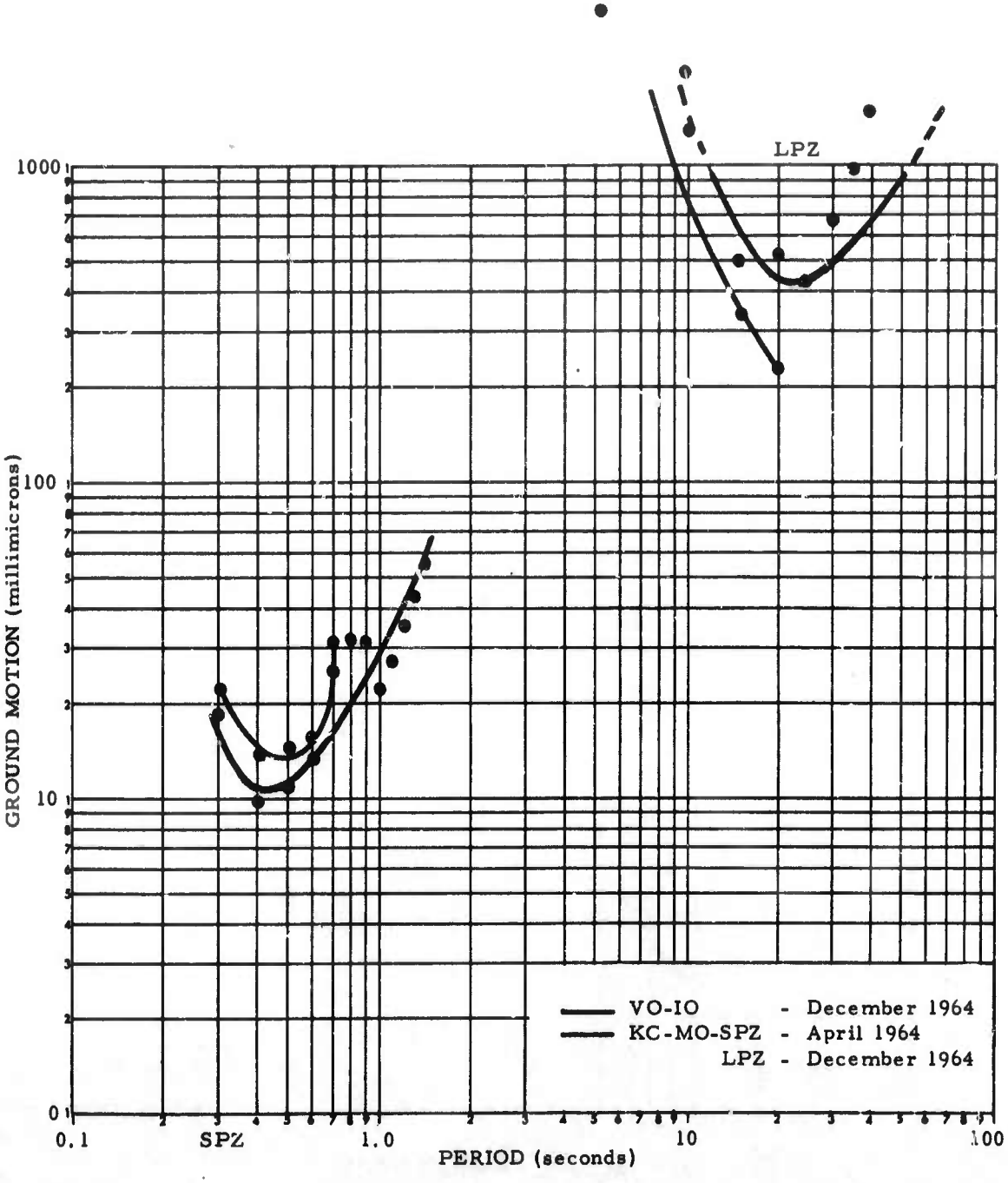
Noise spectrum curve, LRSM



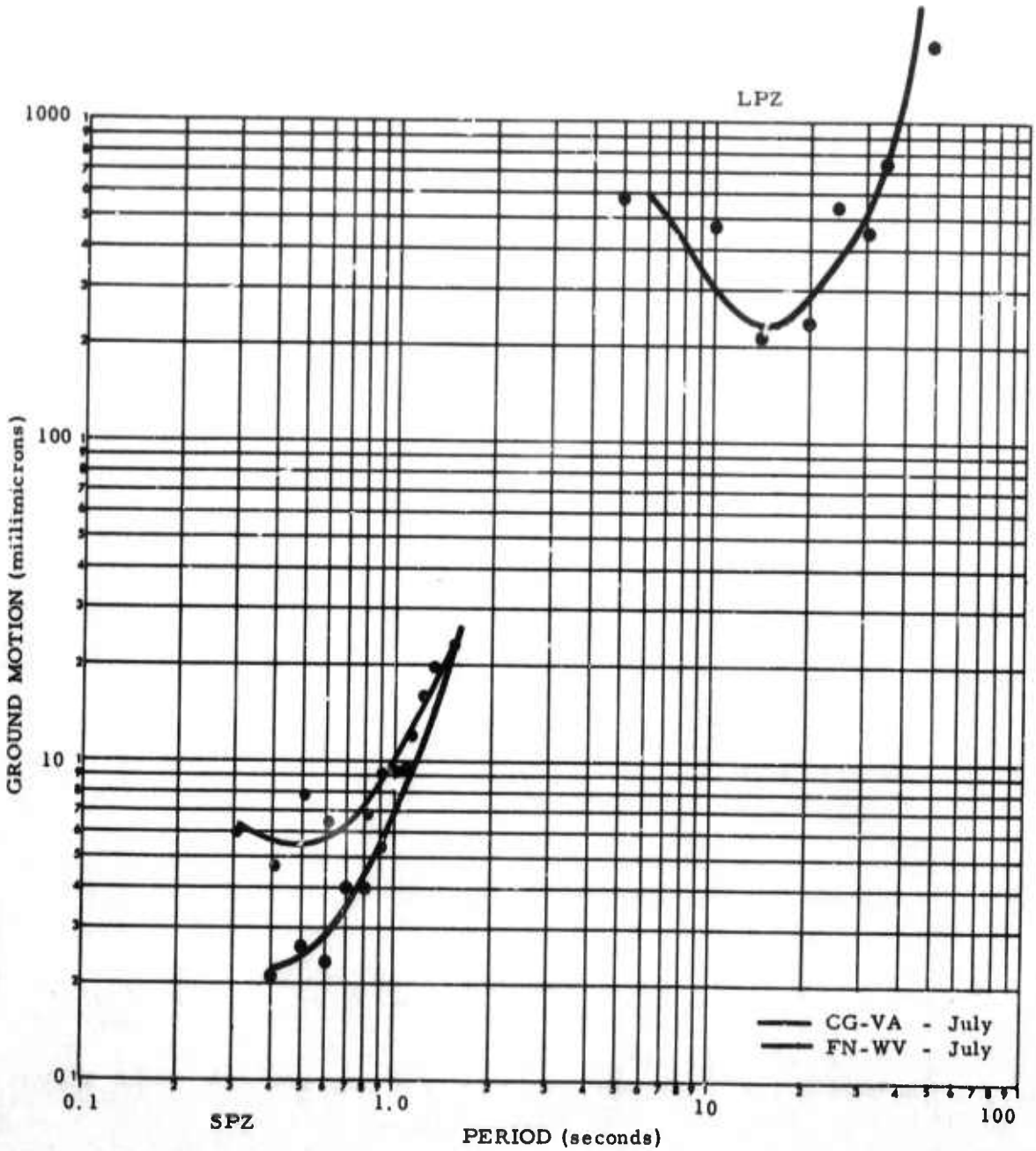
Noise spectrum curve, LRSM



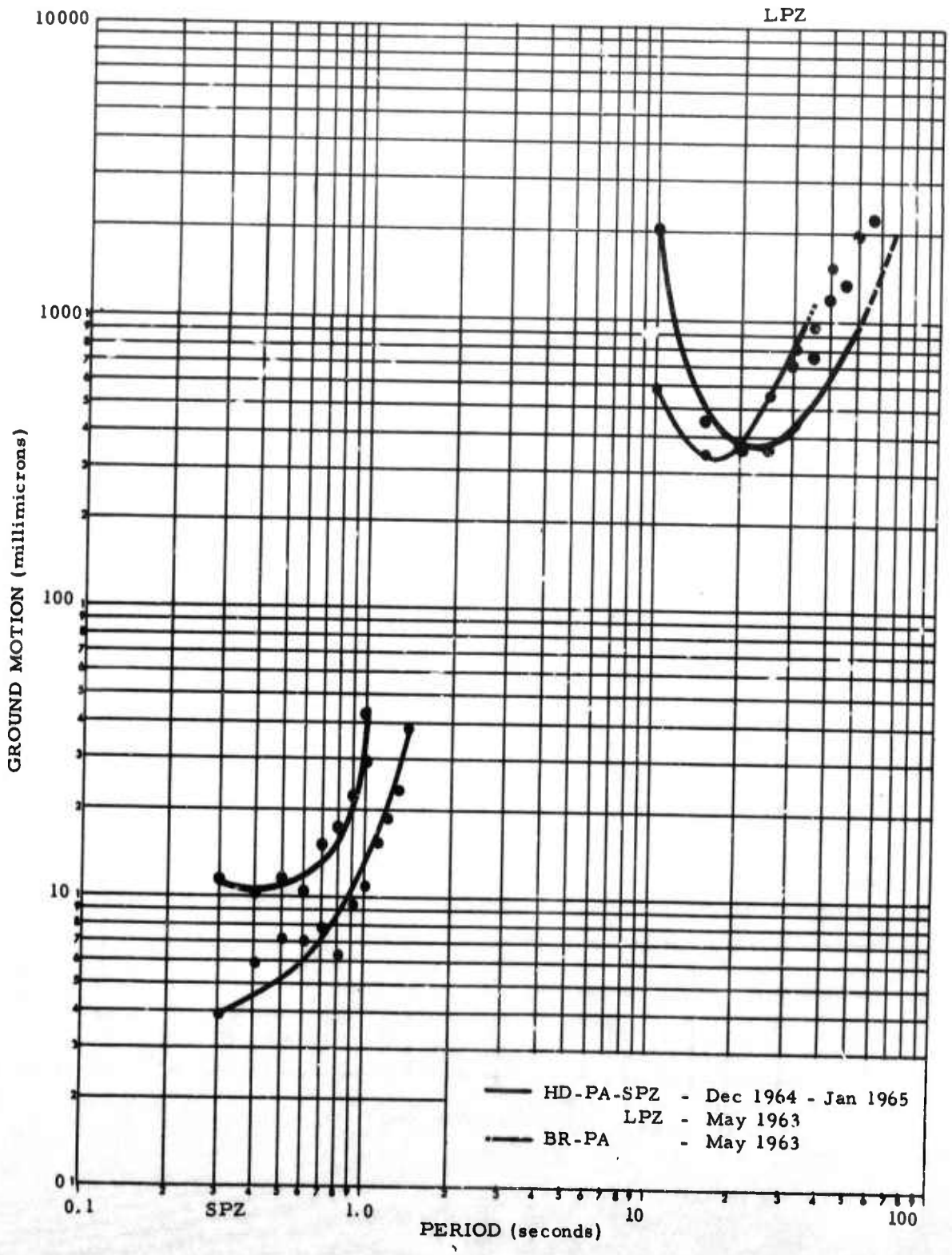
Noise spectrum curve, LRSM



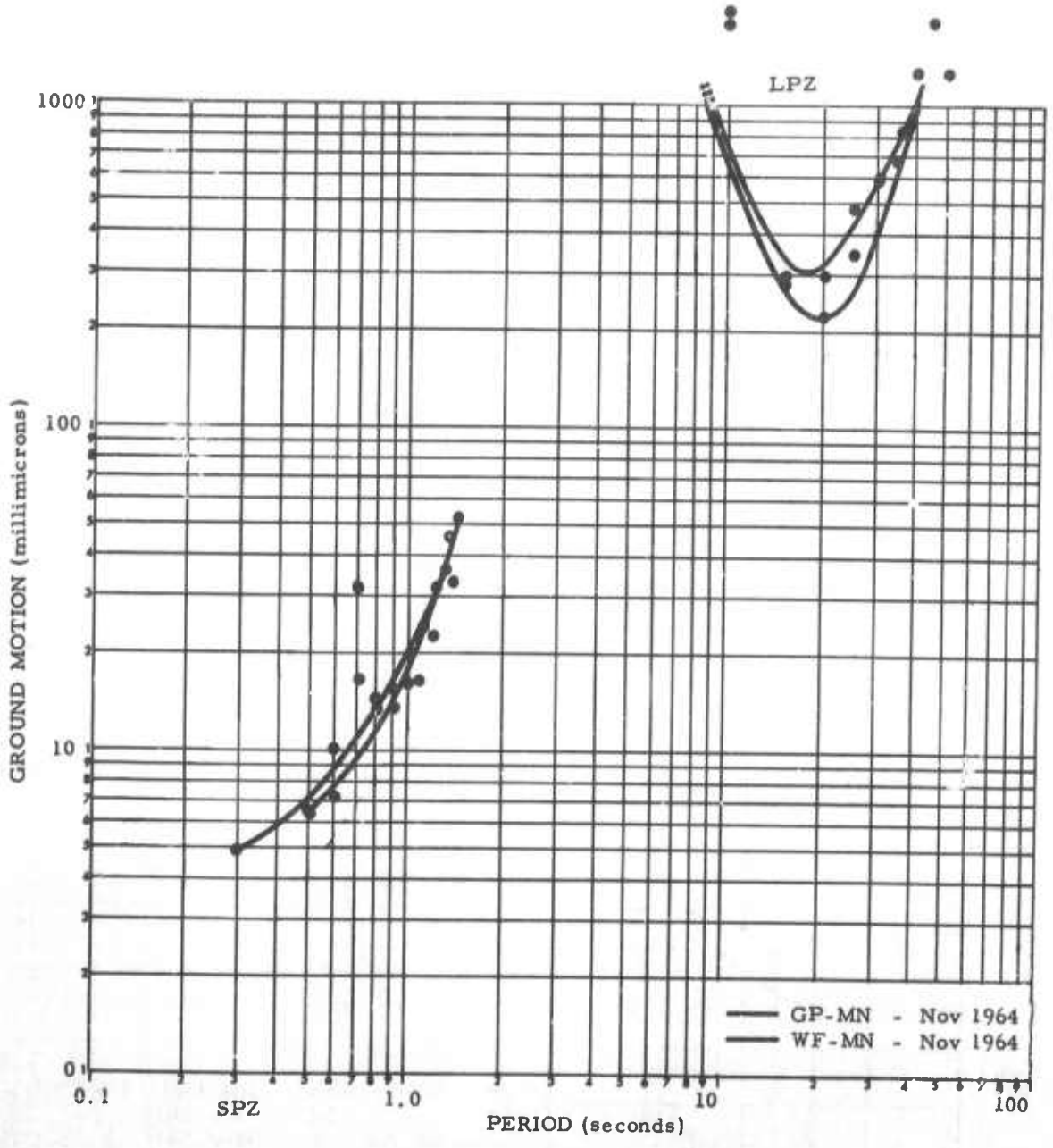
Noise spectrum curve, LRSM



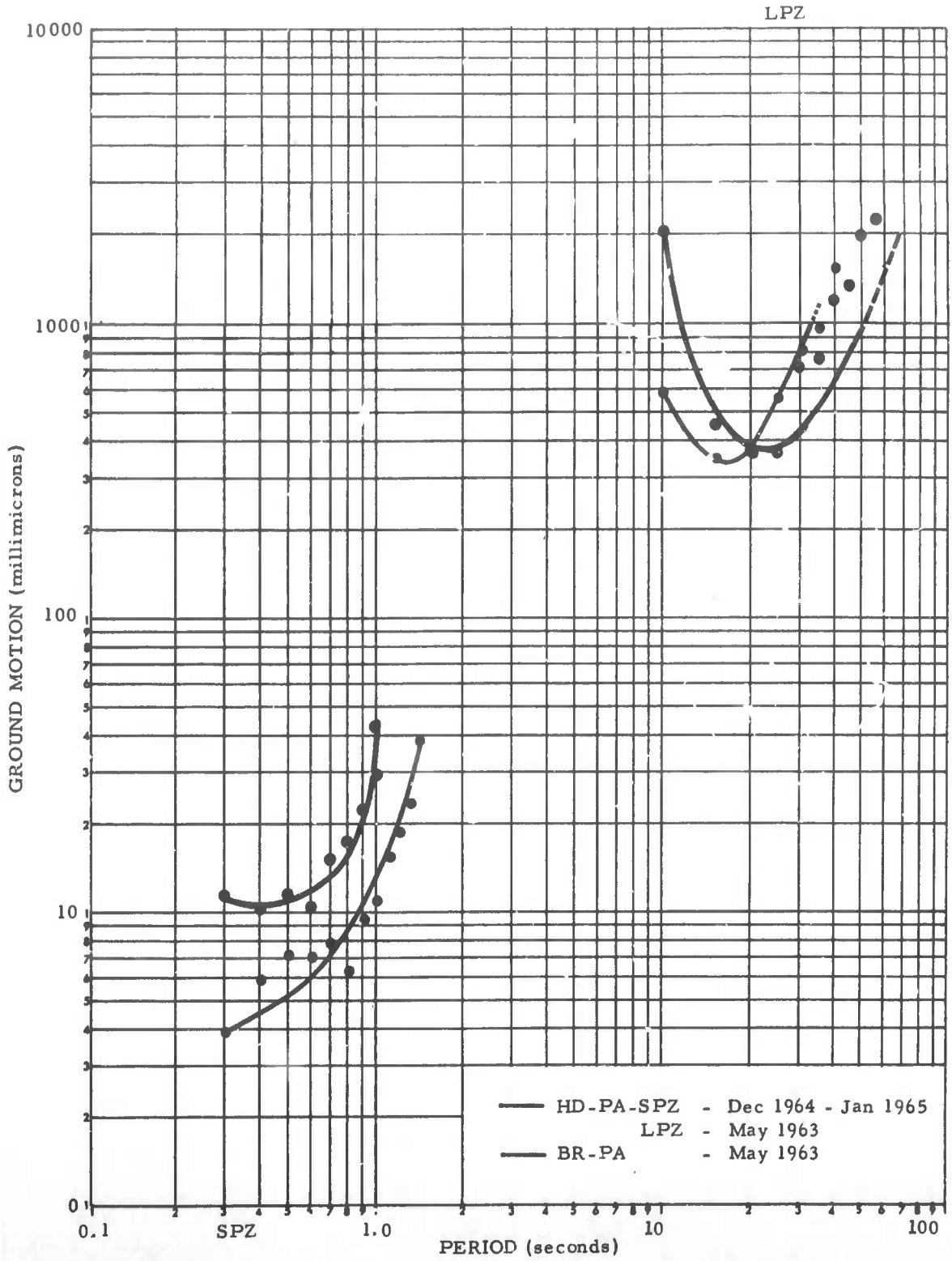
Noise spectrum curve, LRSM



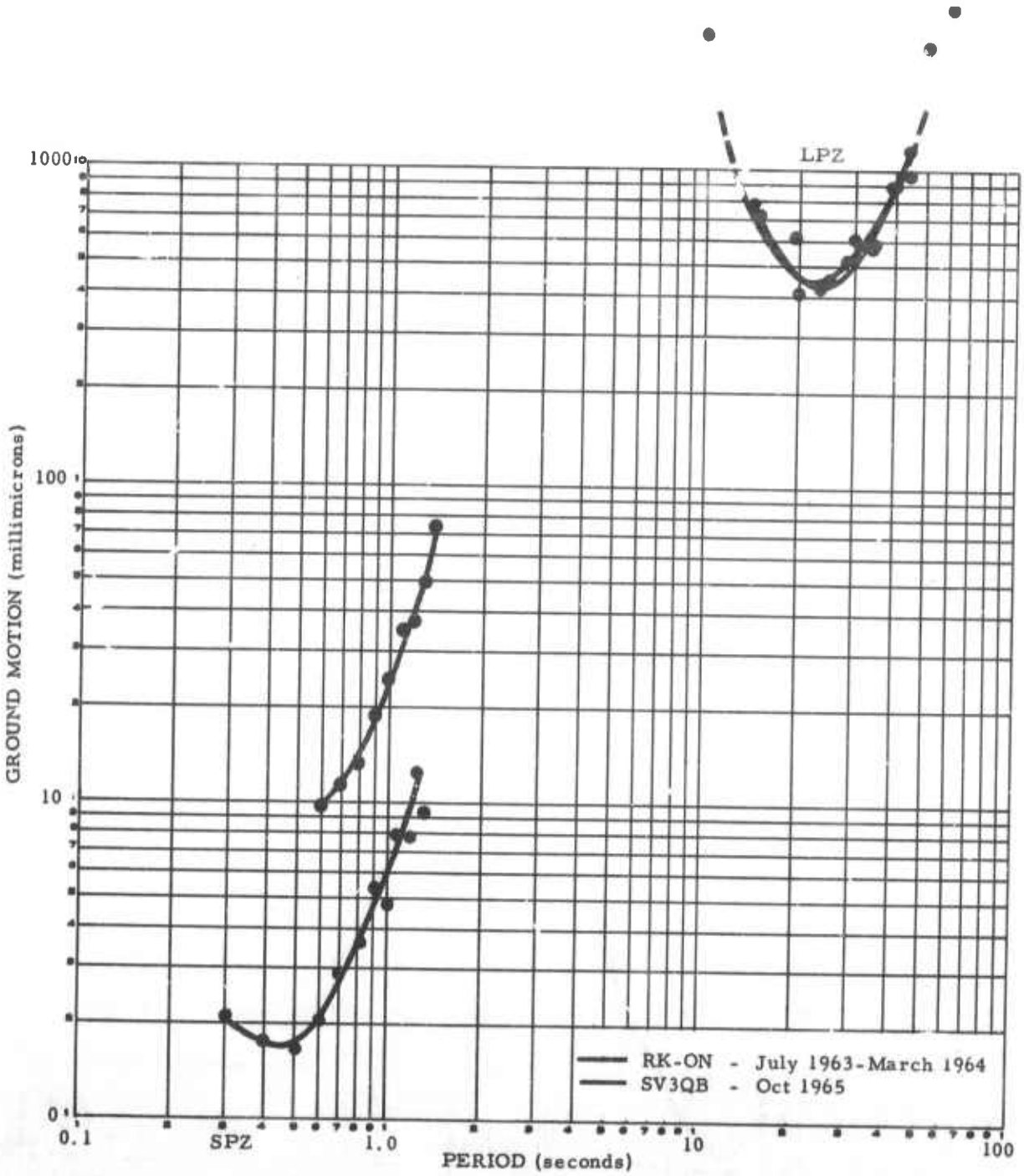
Noise spectrum curve, LRSM



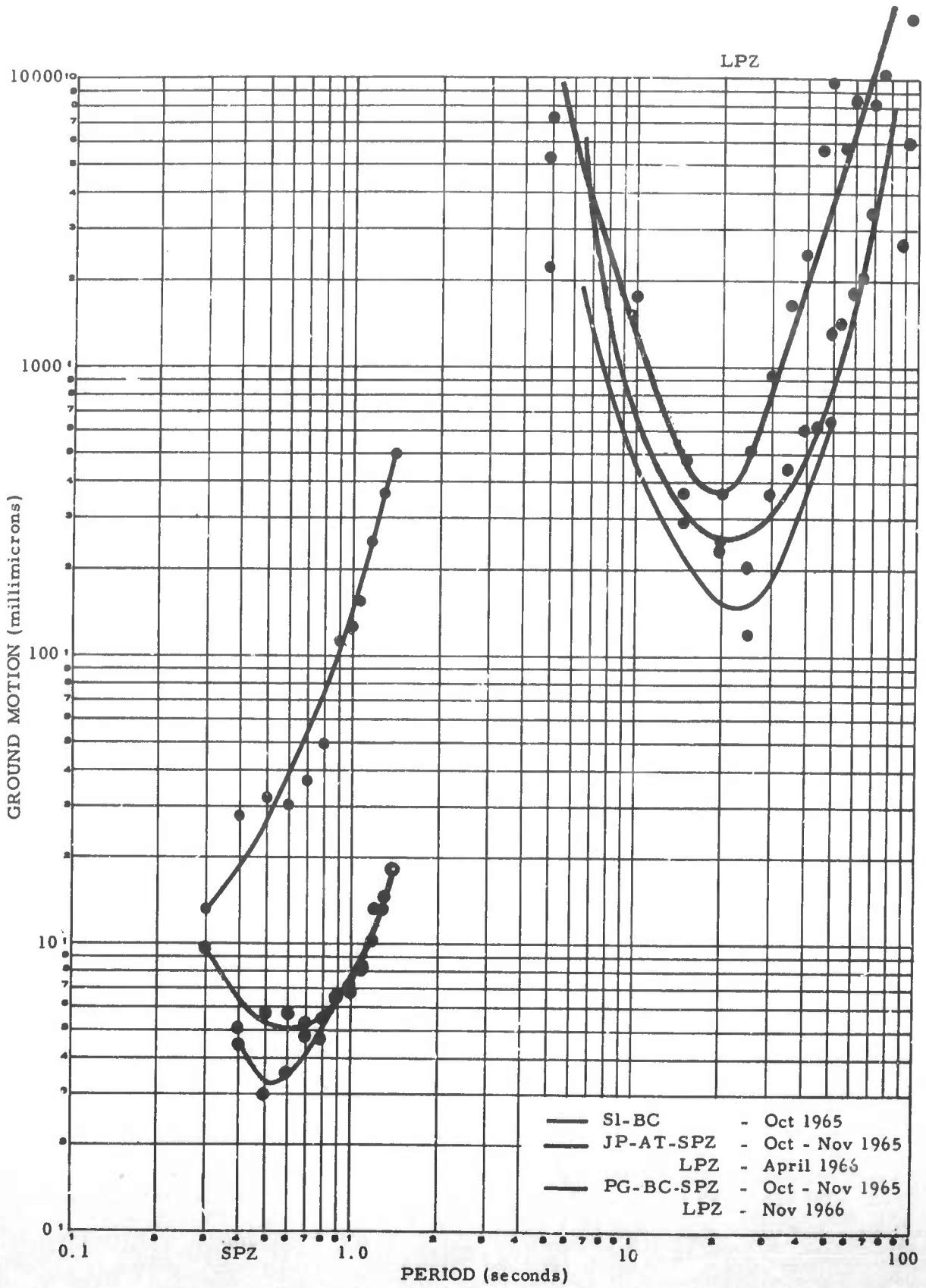
Noise spectrum curve, LRSM



Noise spectrum curve, LRSM



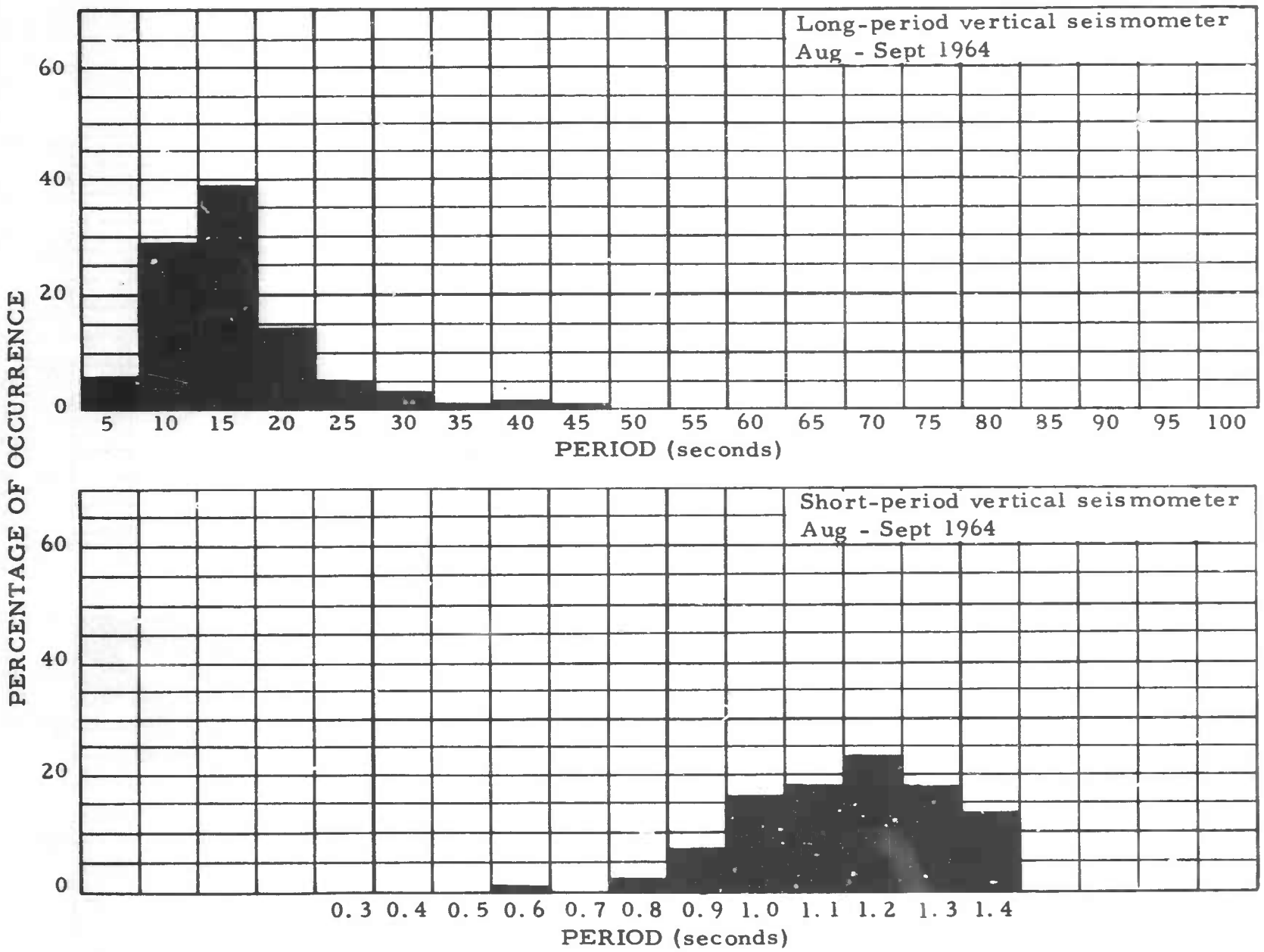
Noise spectrum curve, LRSM



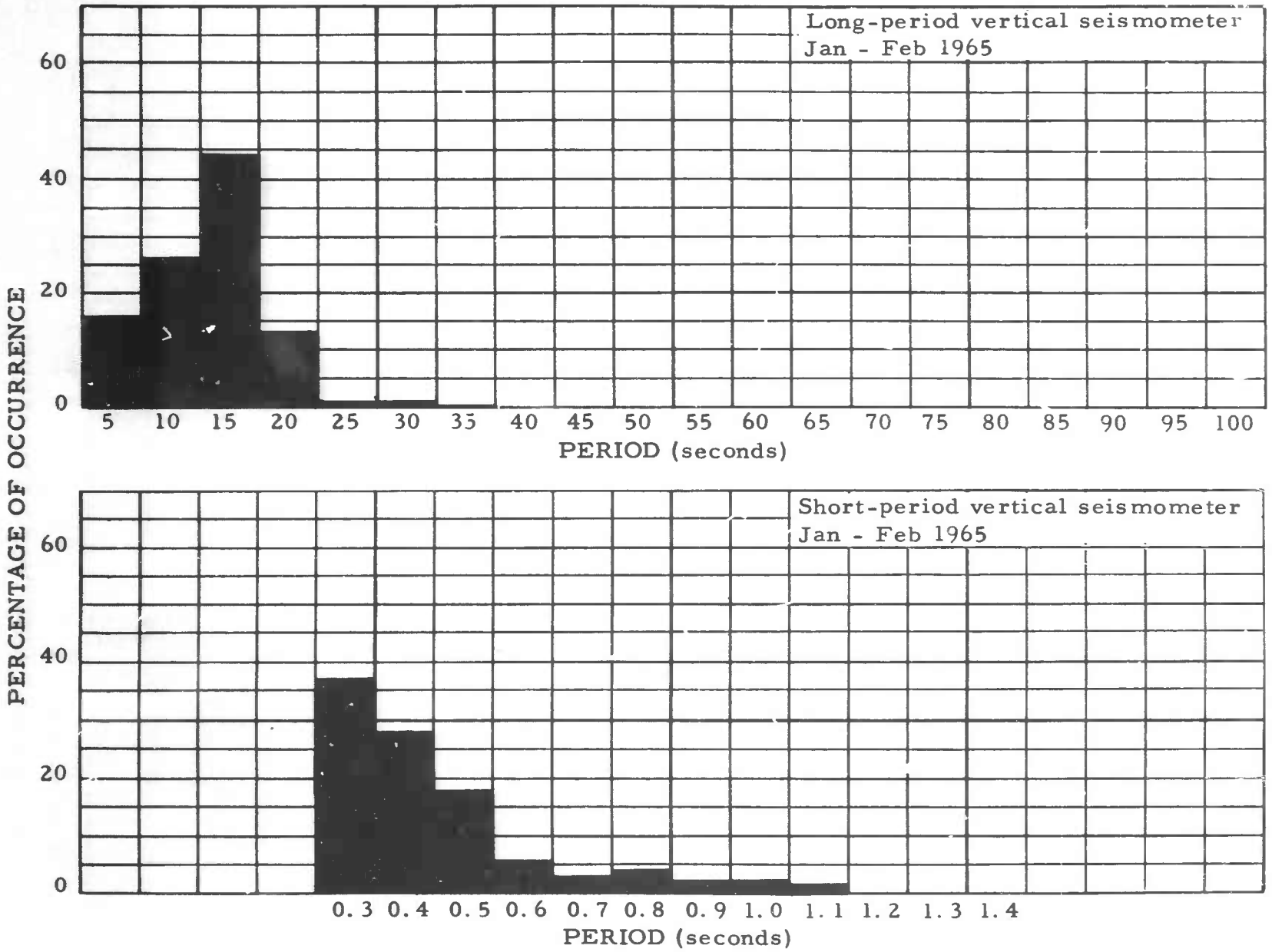
Noise spectrum curve, LRSM

APPENDIX 4 to TECHNICAL REPORT NC. 67-19

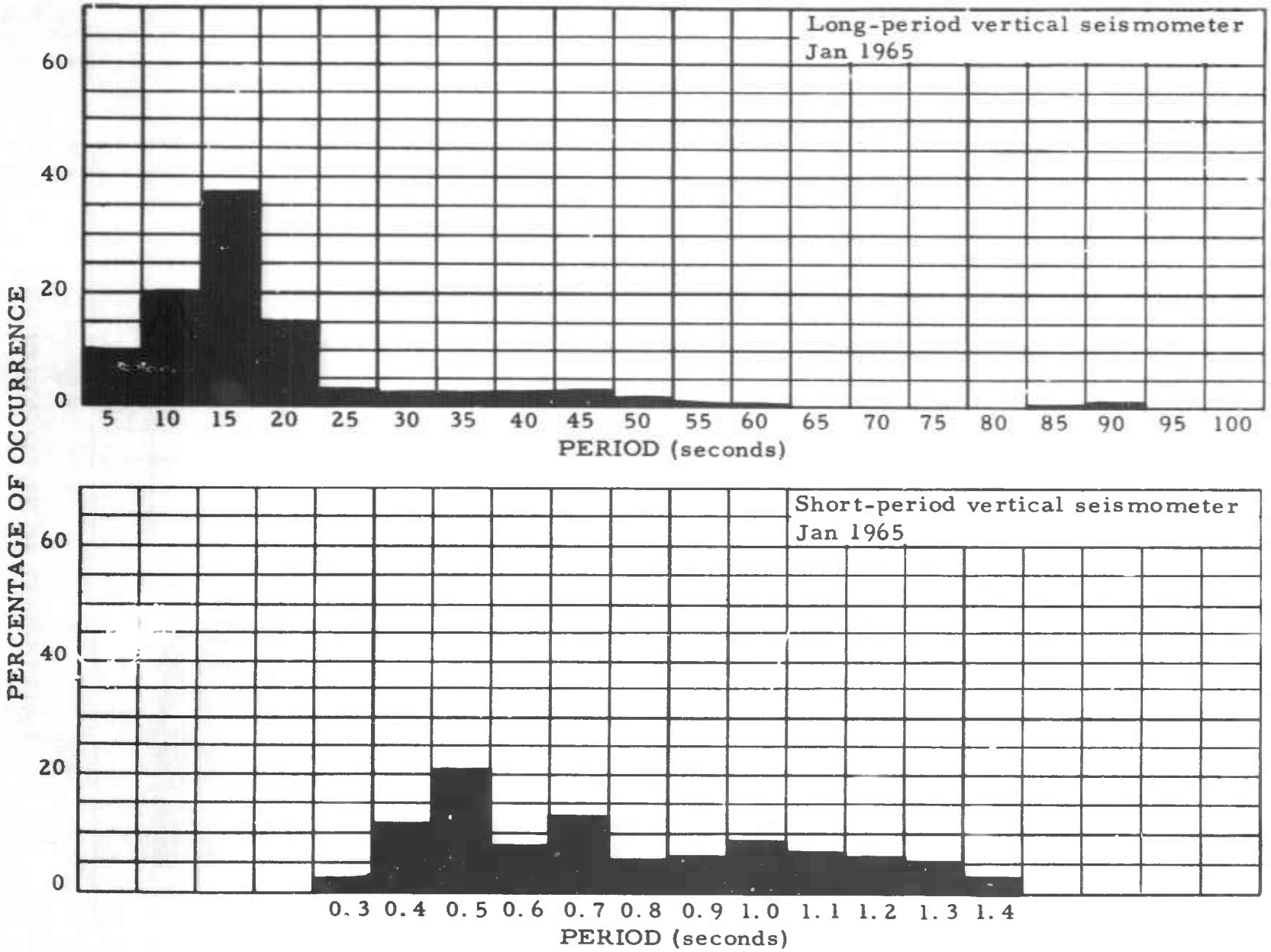
SHORT-PERIOD AND LONG-PERIOD SPECTRUM HISTOGRAMS



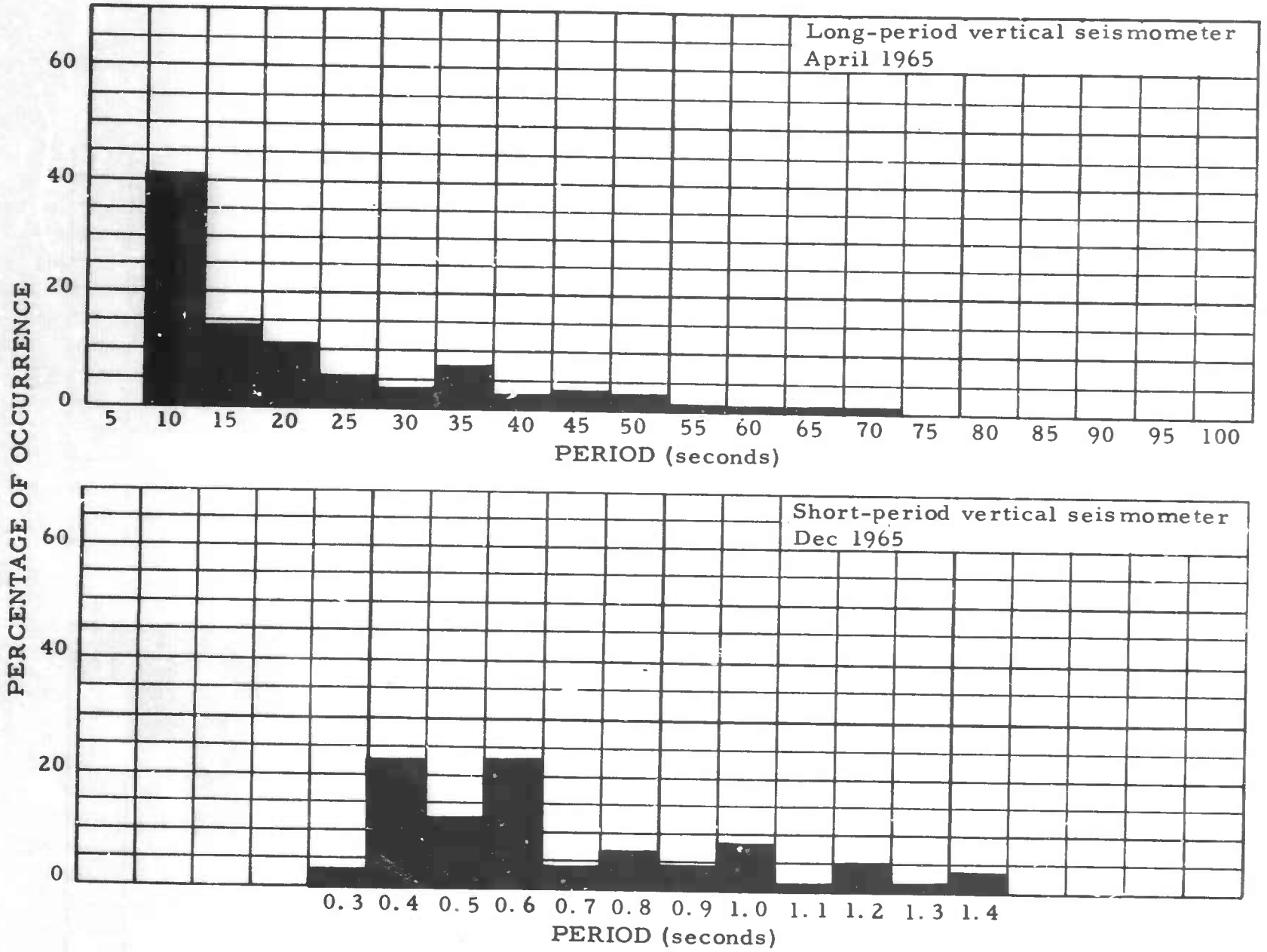
Percentage of occurrence for indicated periods for AD-IS



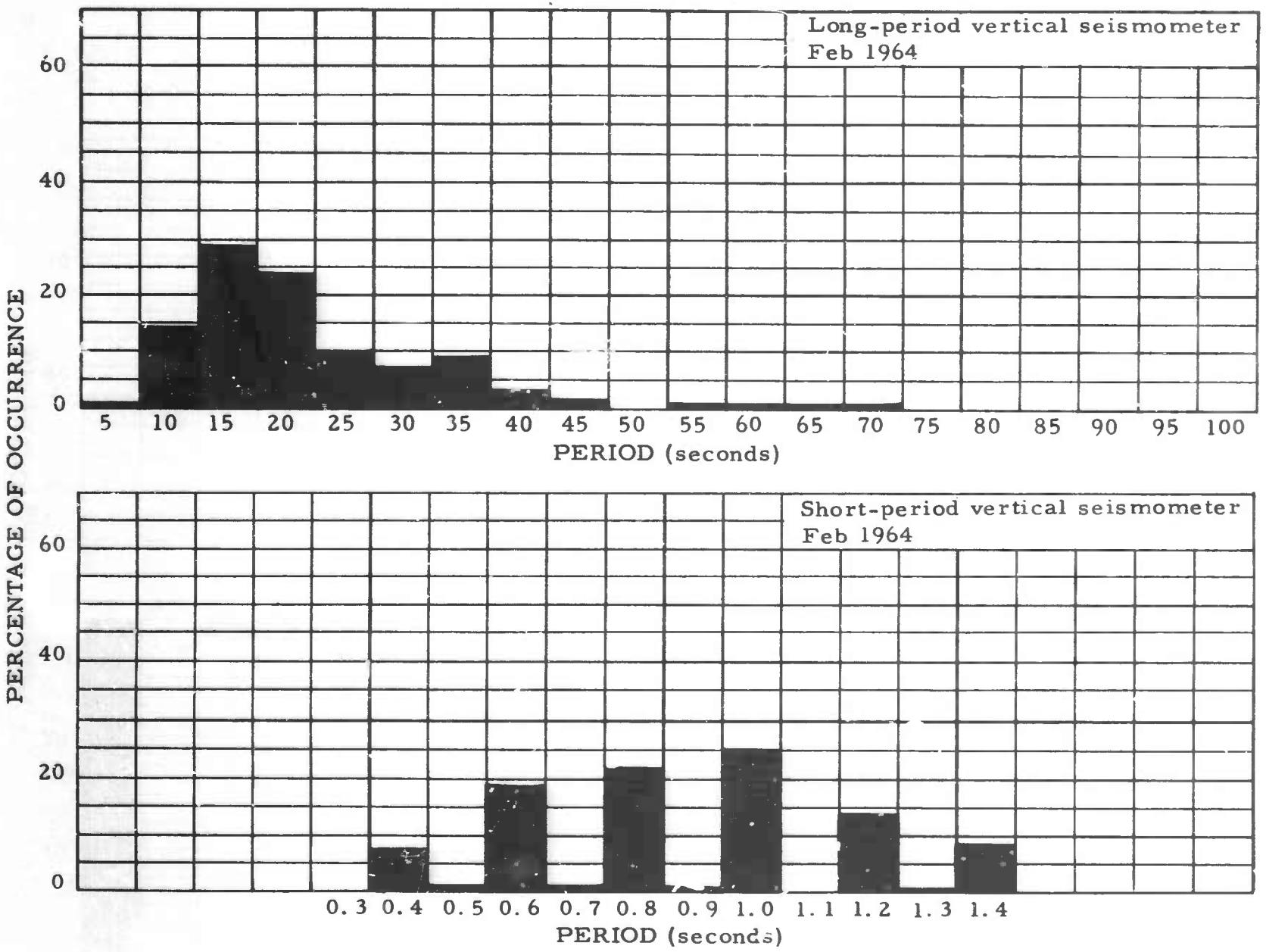
Percentage of occurrence for indicated periods for HY-MA



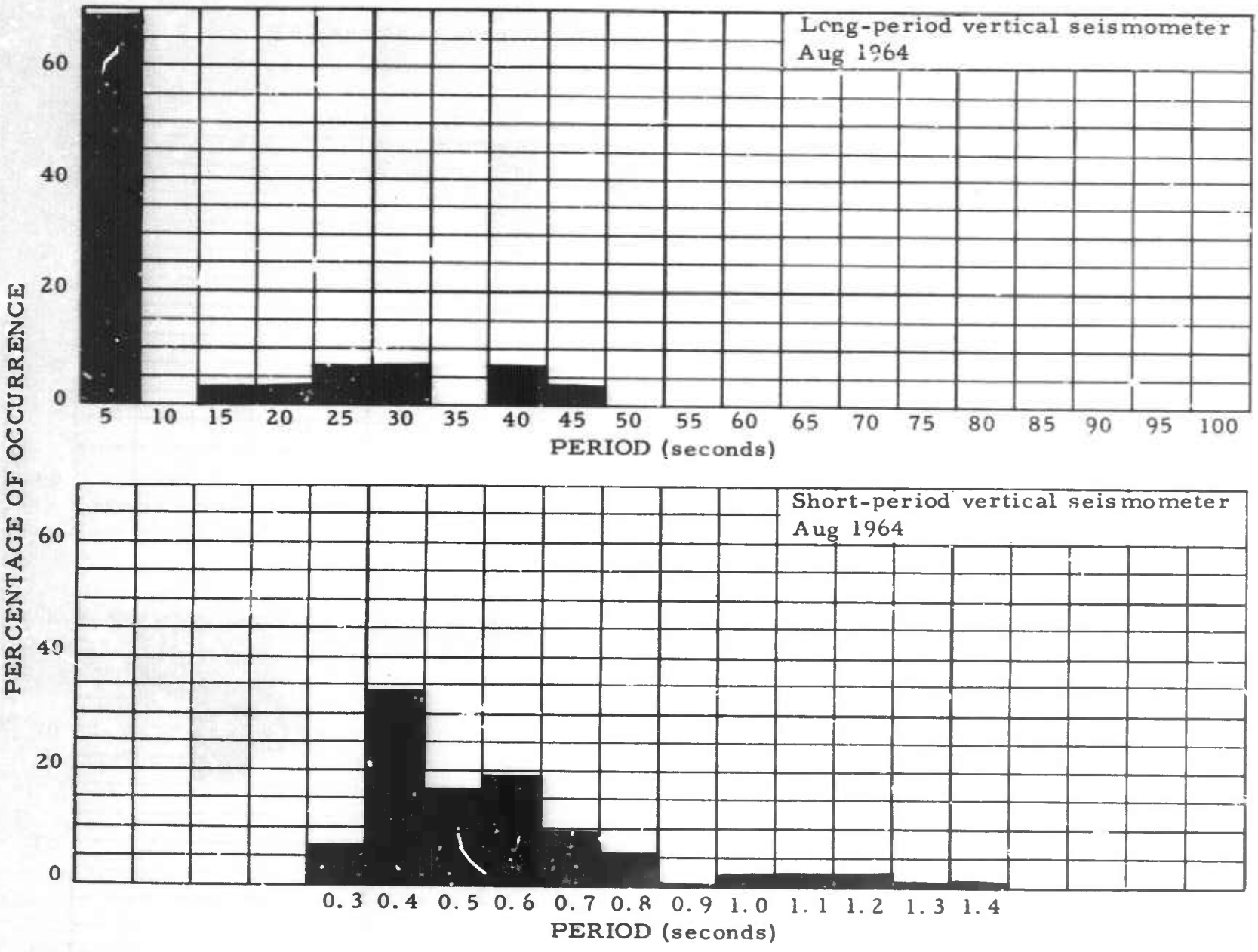
Percentage of occurrence for indicated periods for AN-MA



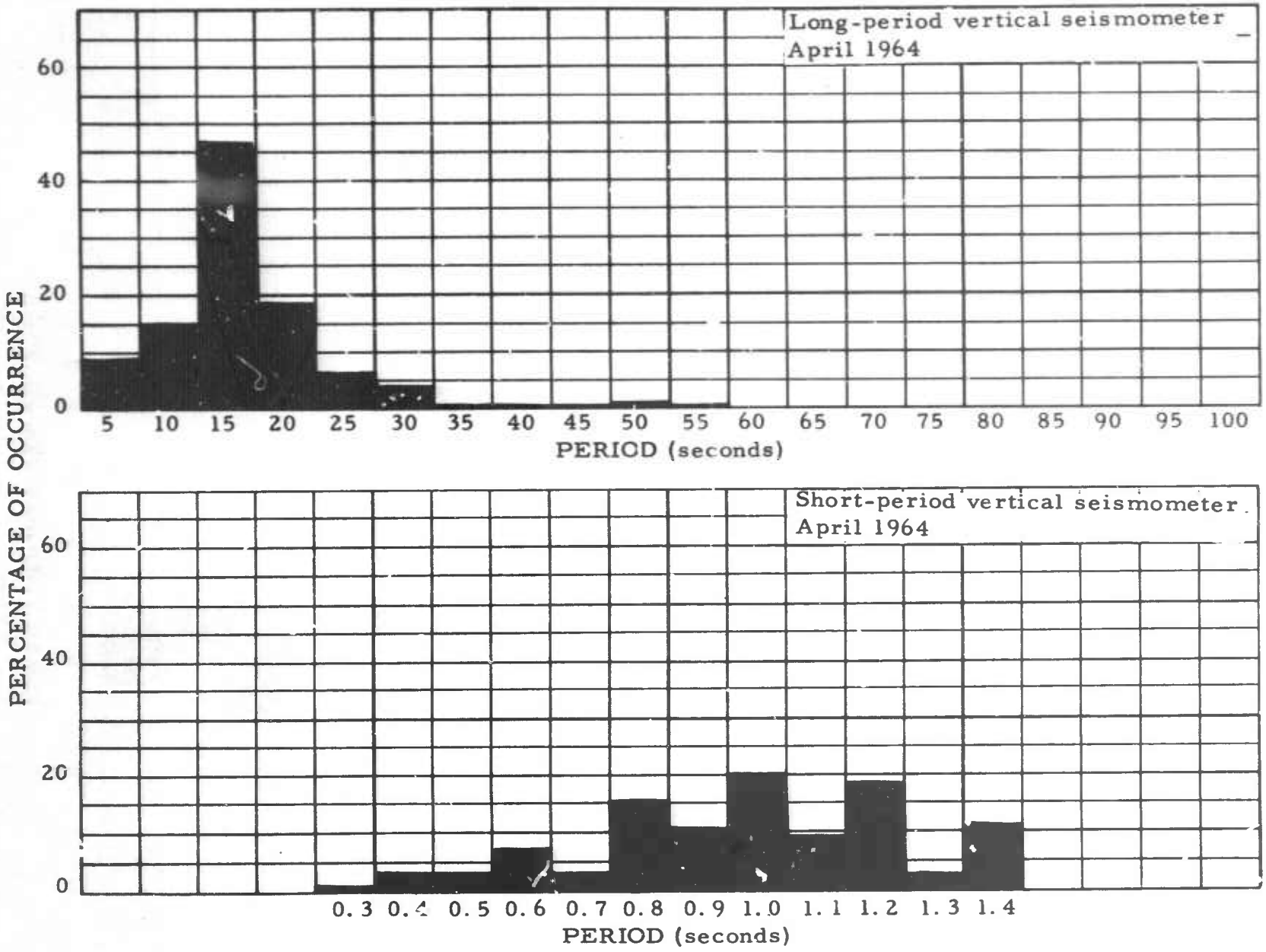
Percentage of occurrence for indicated periods for HL2ID



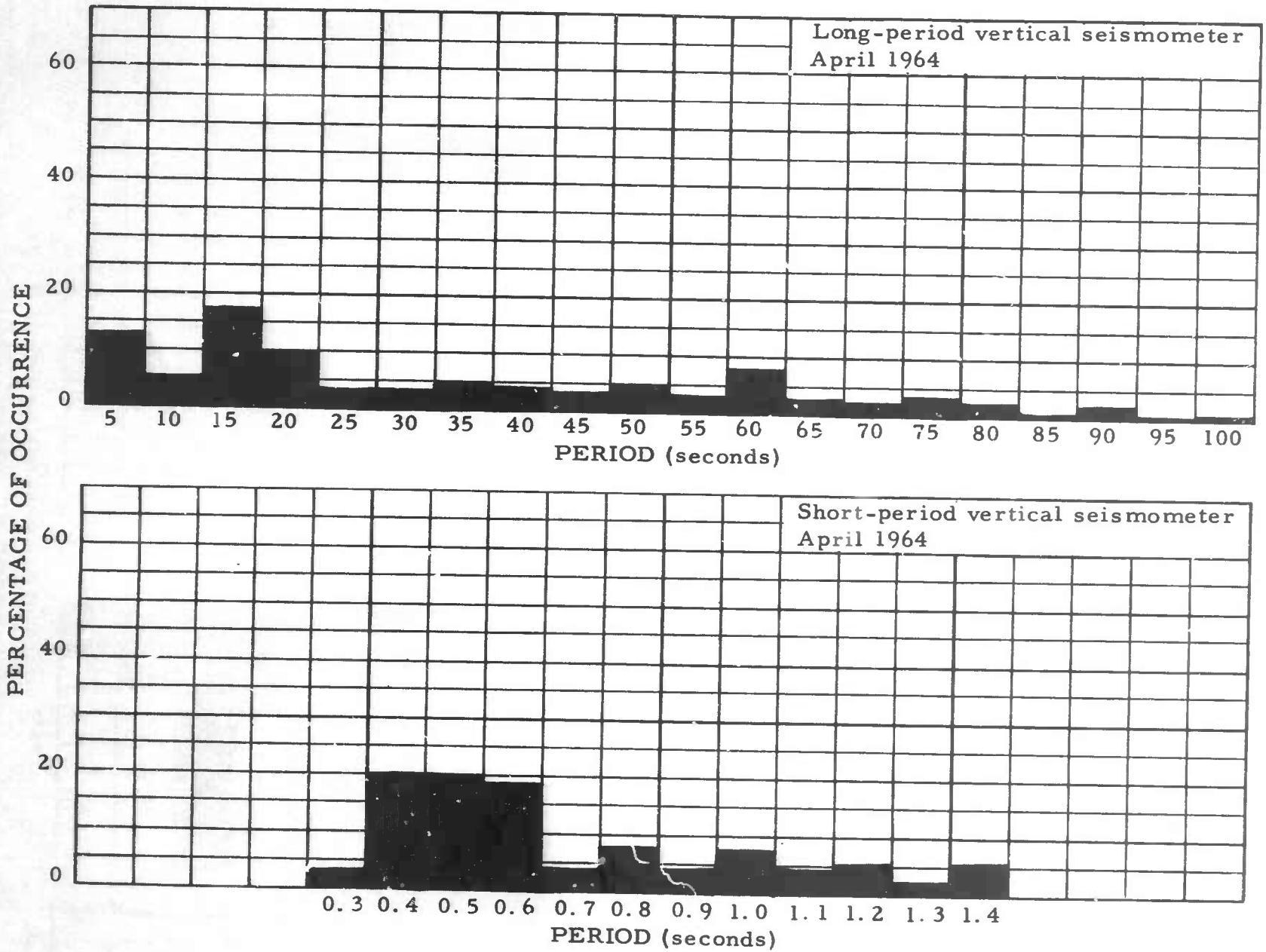
Percentage of occurrence for indicated periods for EK-NV



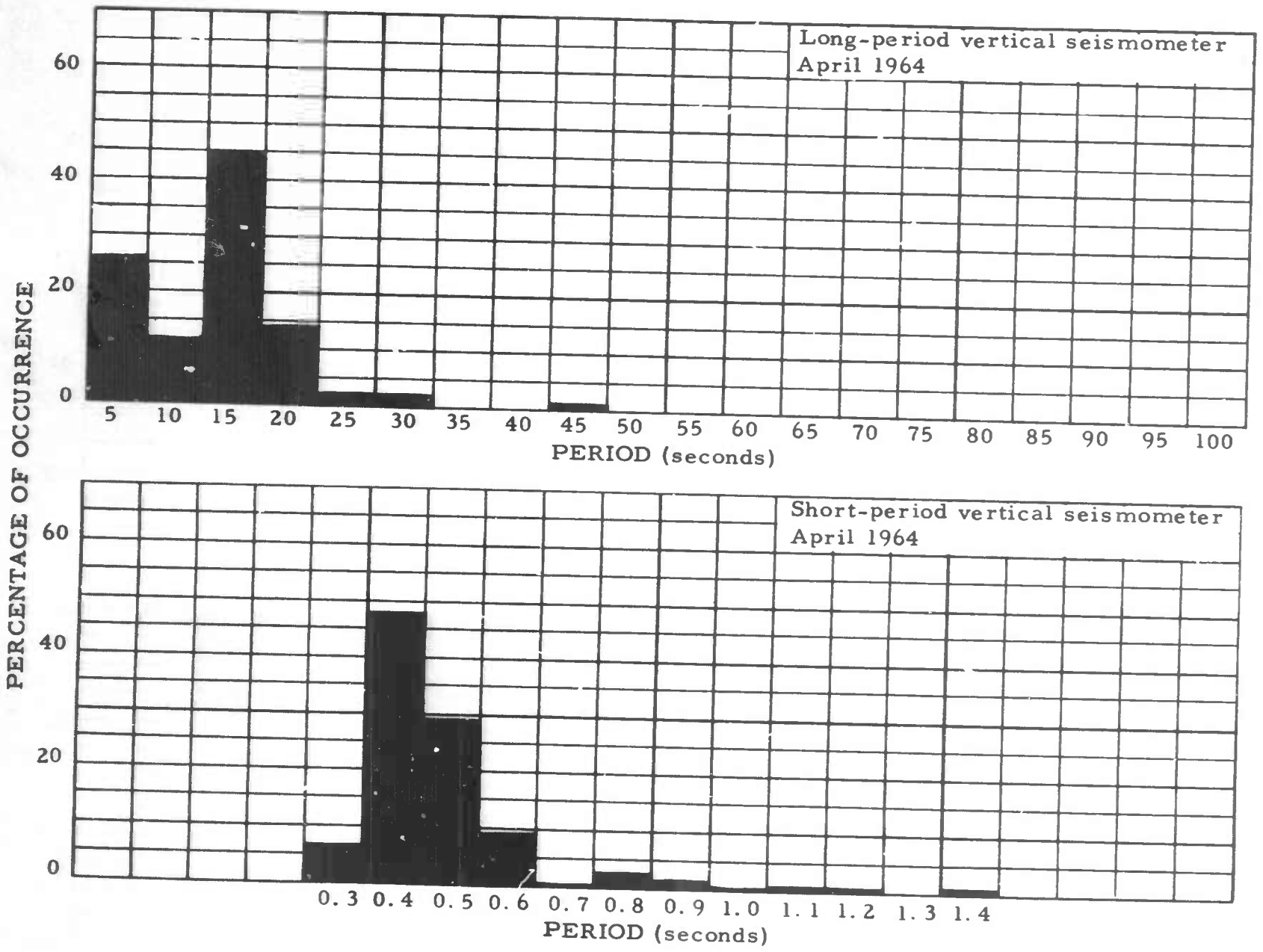
Percentage of occurrence for indicated periods for GE-AZ



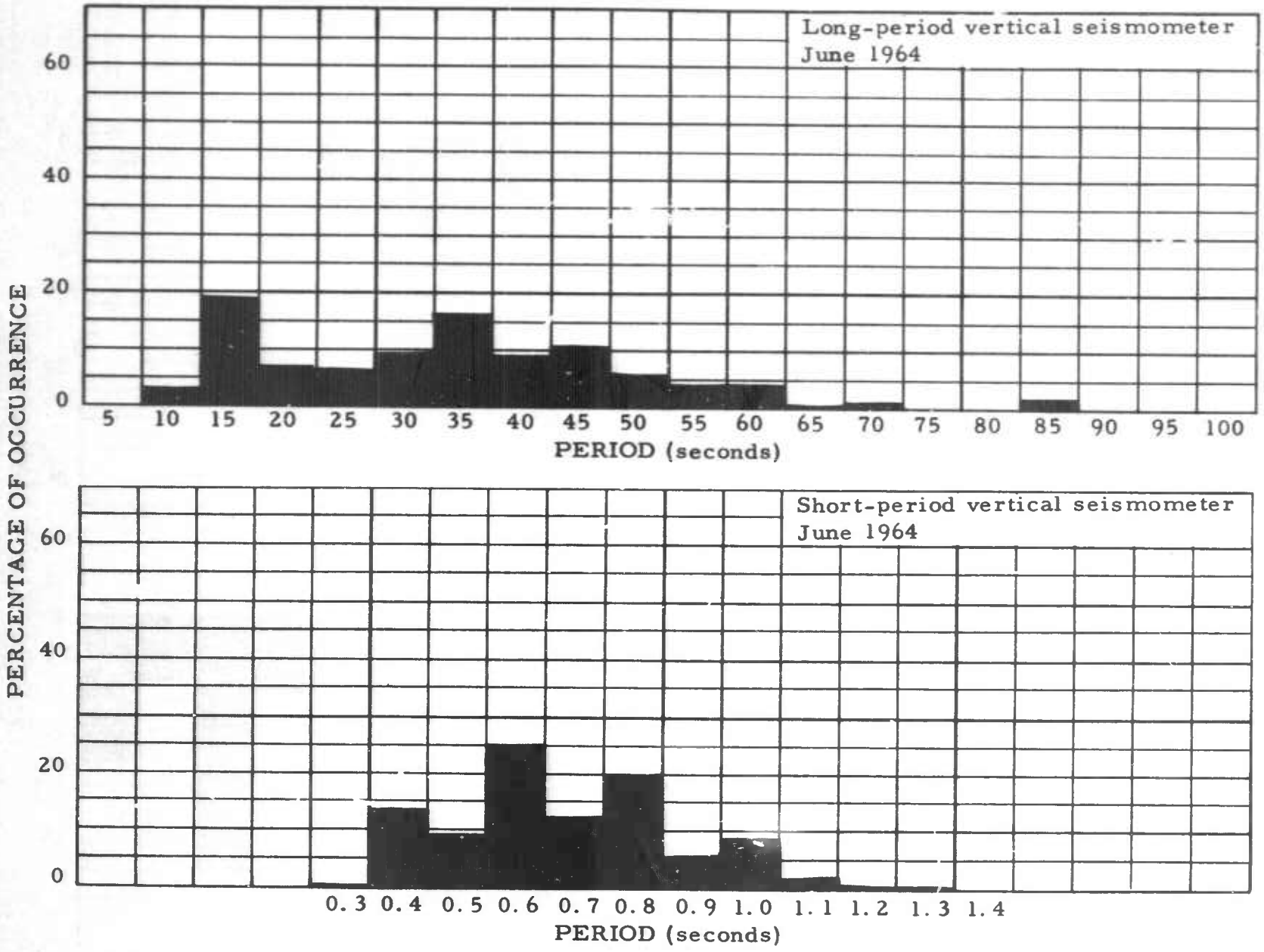
Percentage of occurrence for indicated periods for LG-AZ



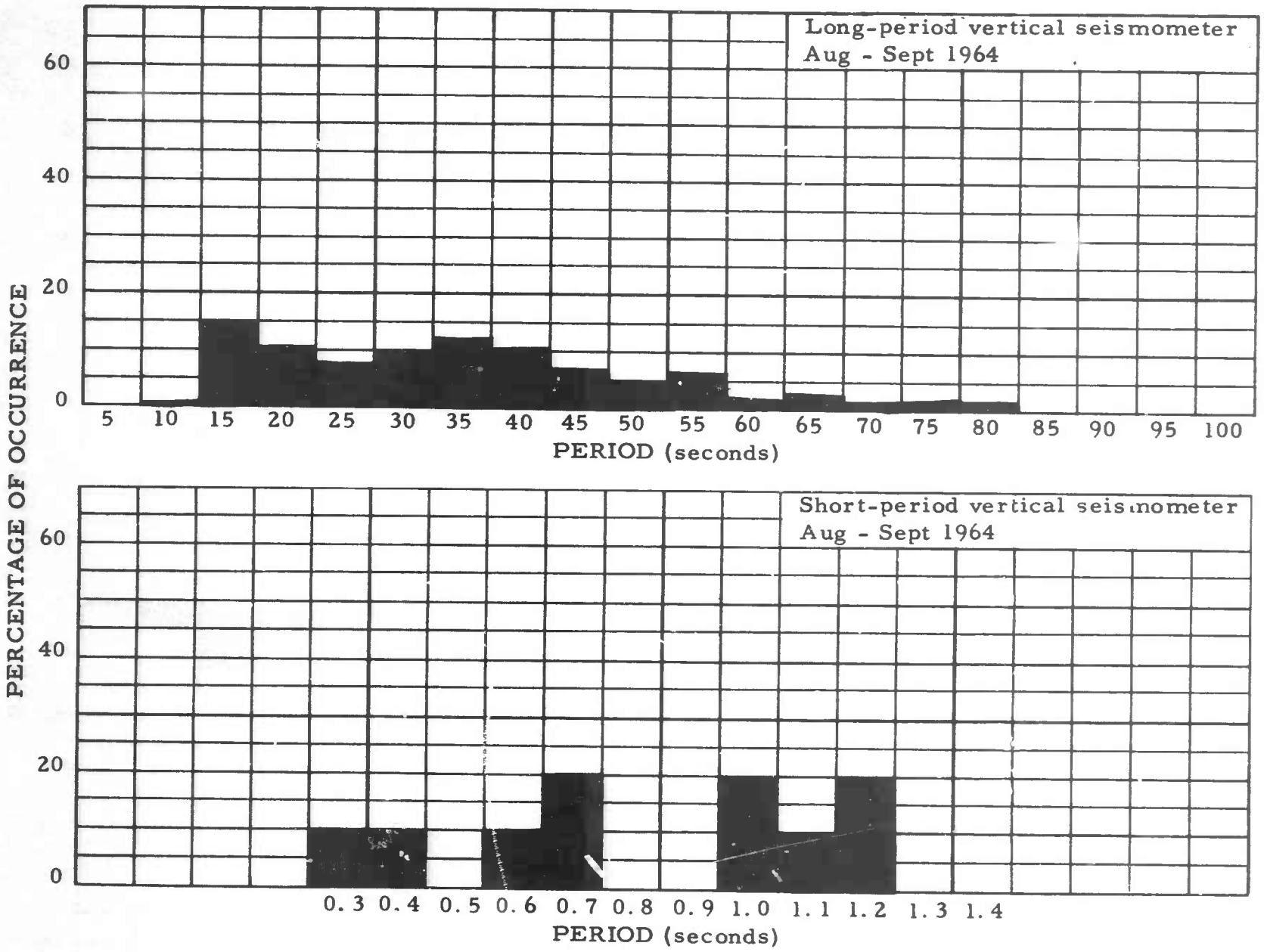
Percentage of occurrence for indicated periods for NL2AZ



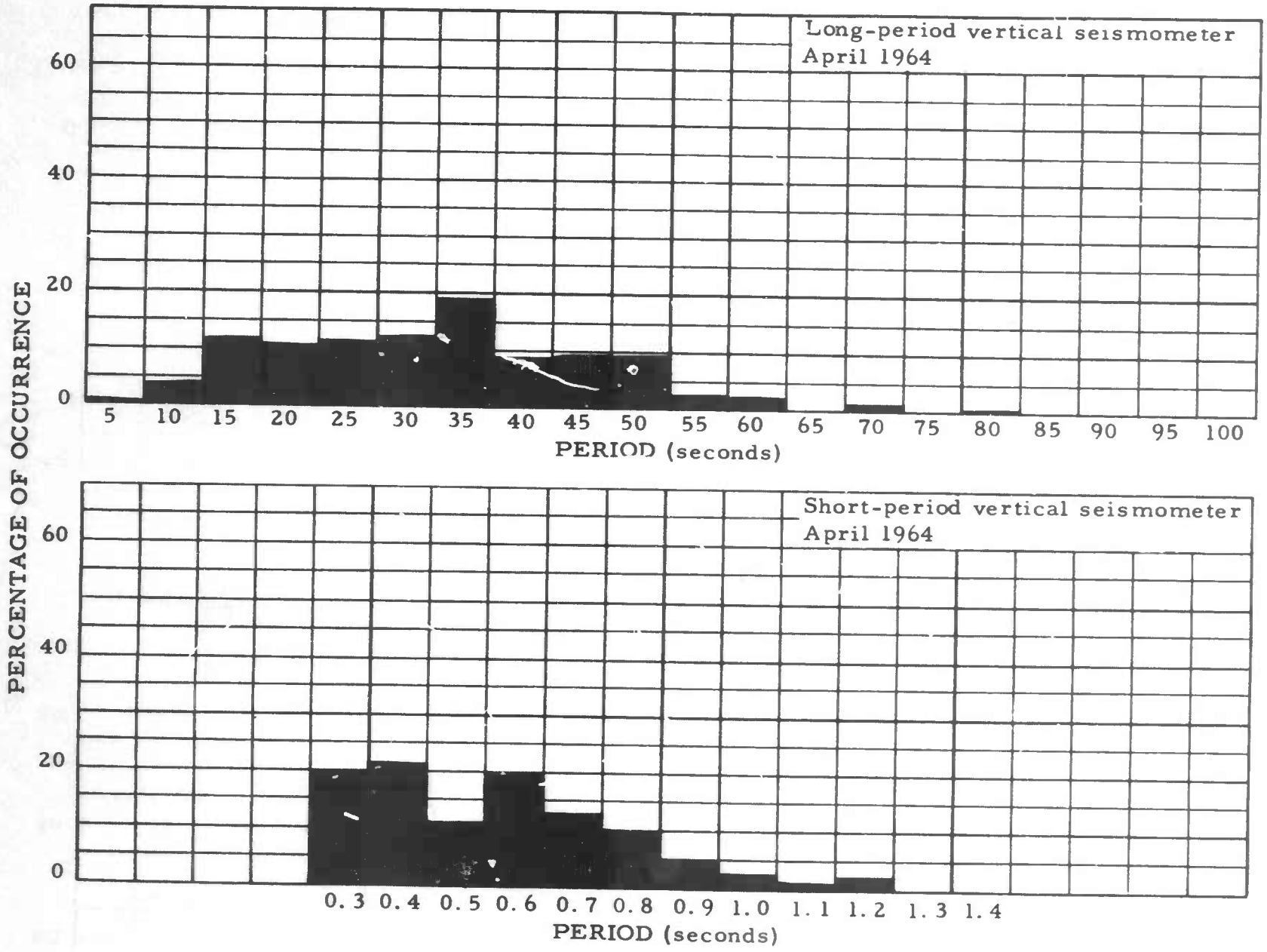
Percentage of occurrence for indicated periods for WO-AZ



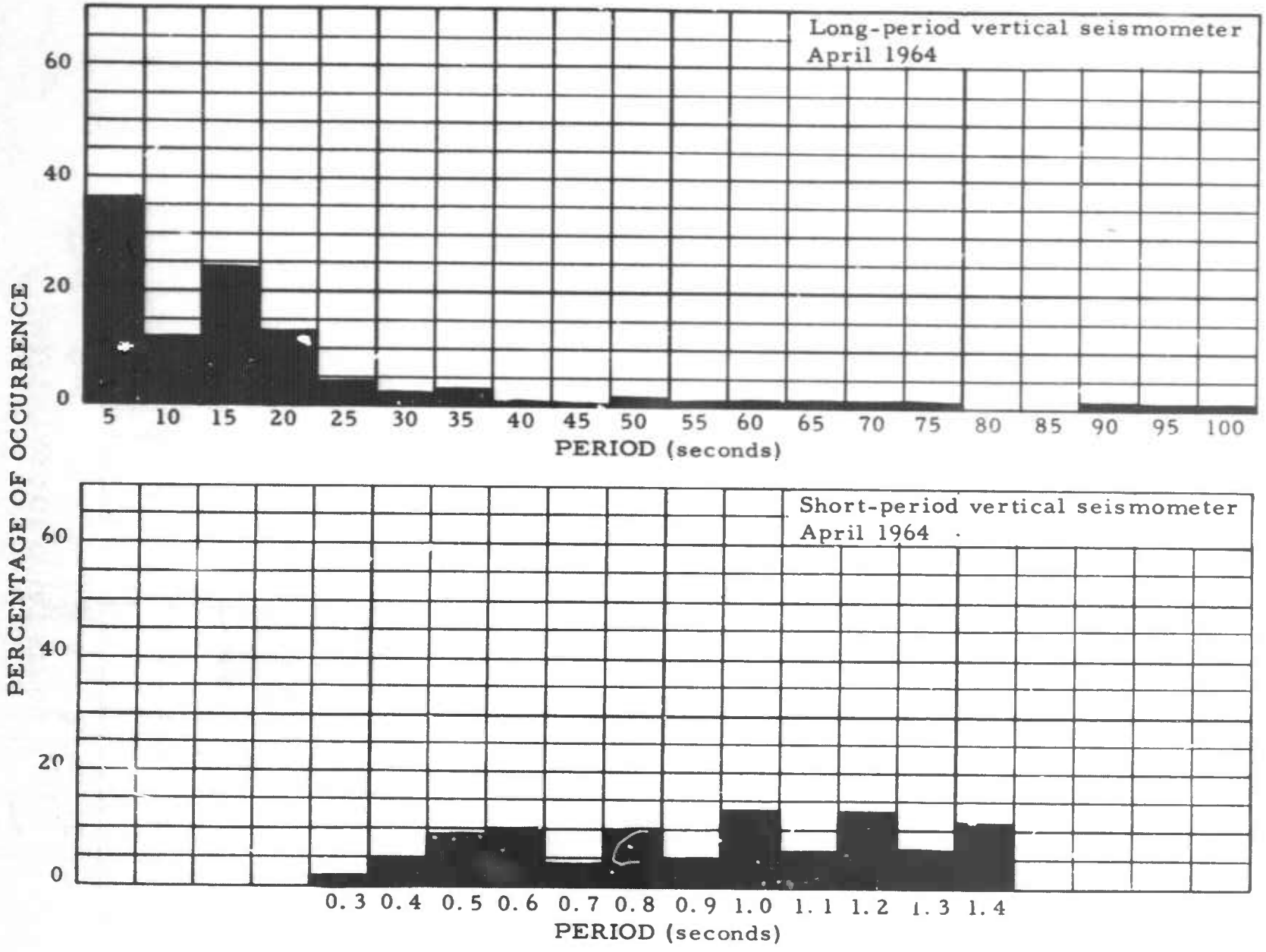
Percentage of occurrence for indicated periods for KH-AZ



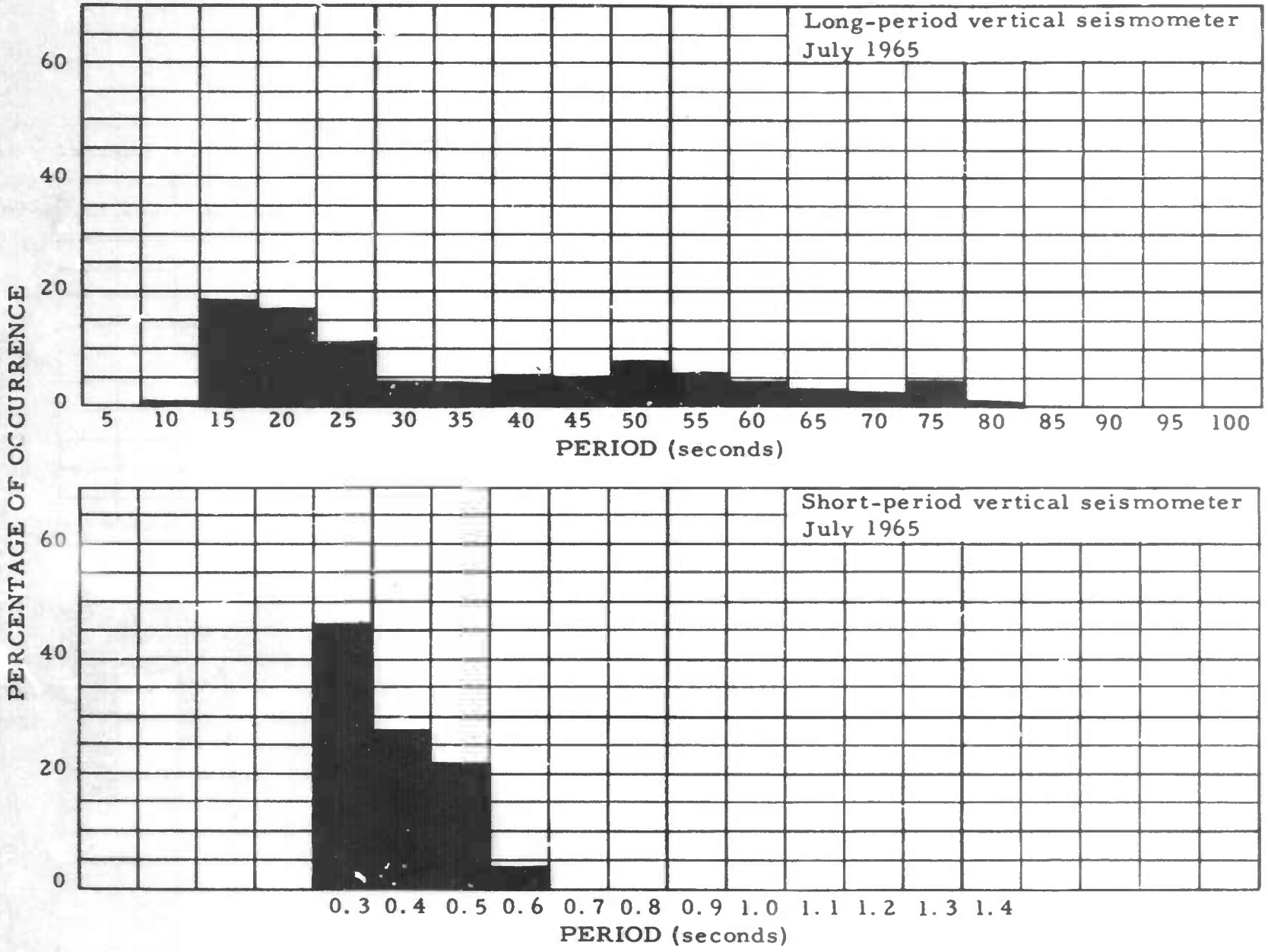
Percentage of occurrence for indicated periods for HR-AZ



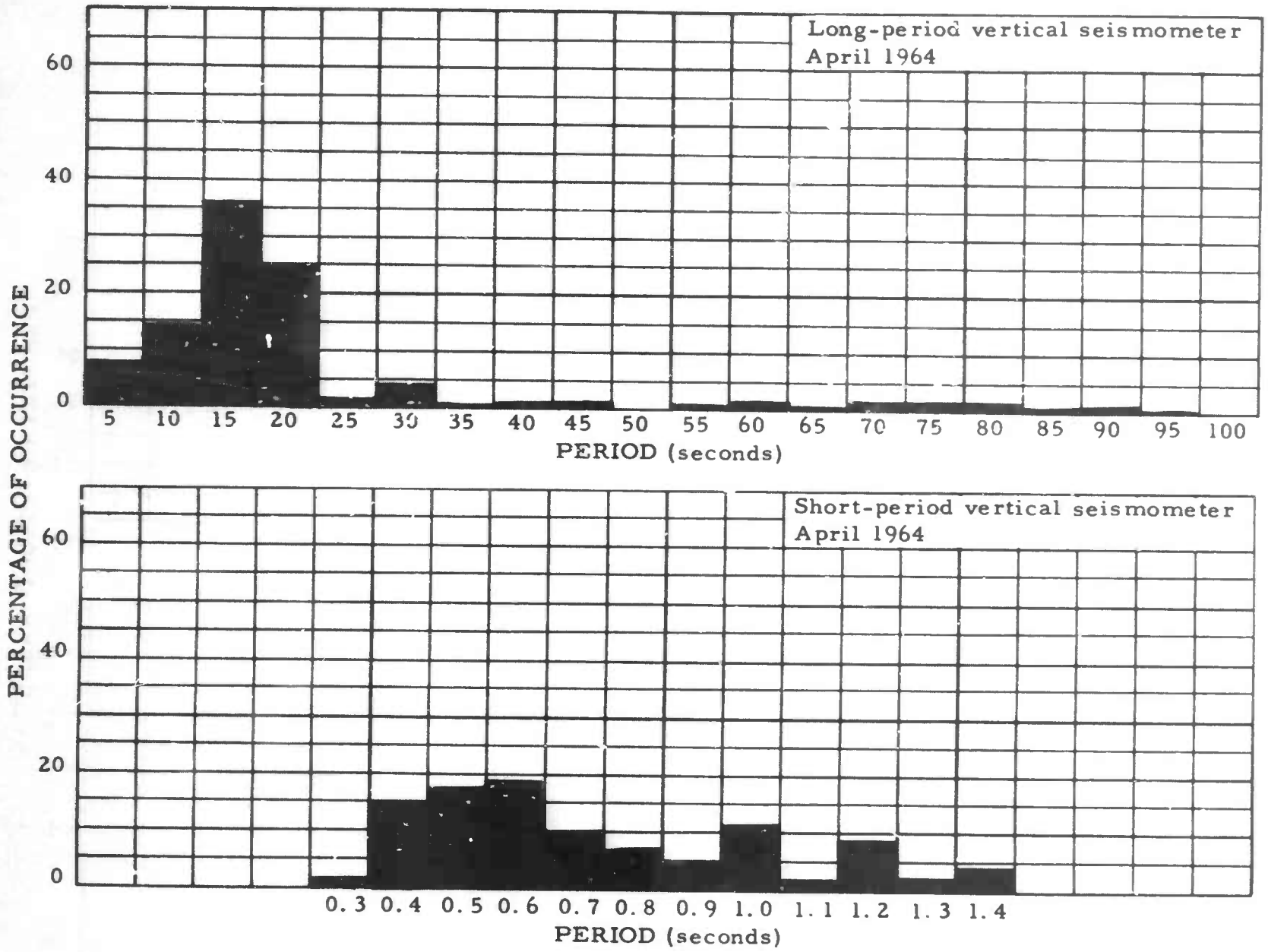
Percentage of occurrence for indicated periods for NL-AZ



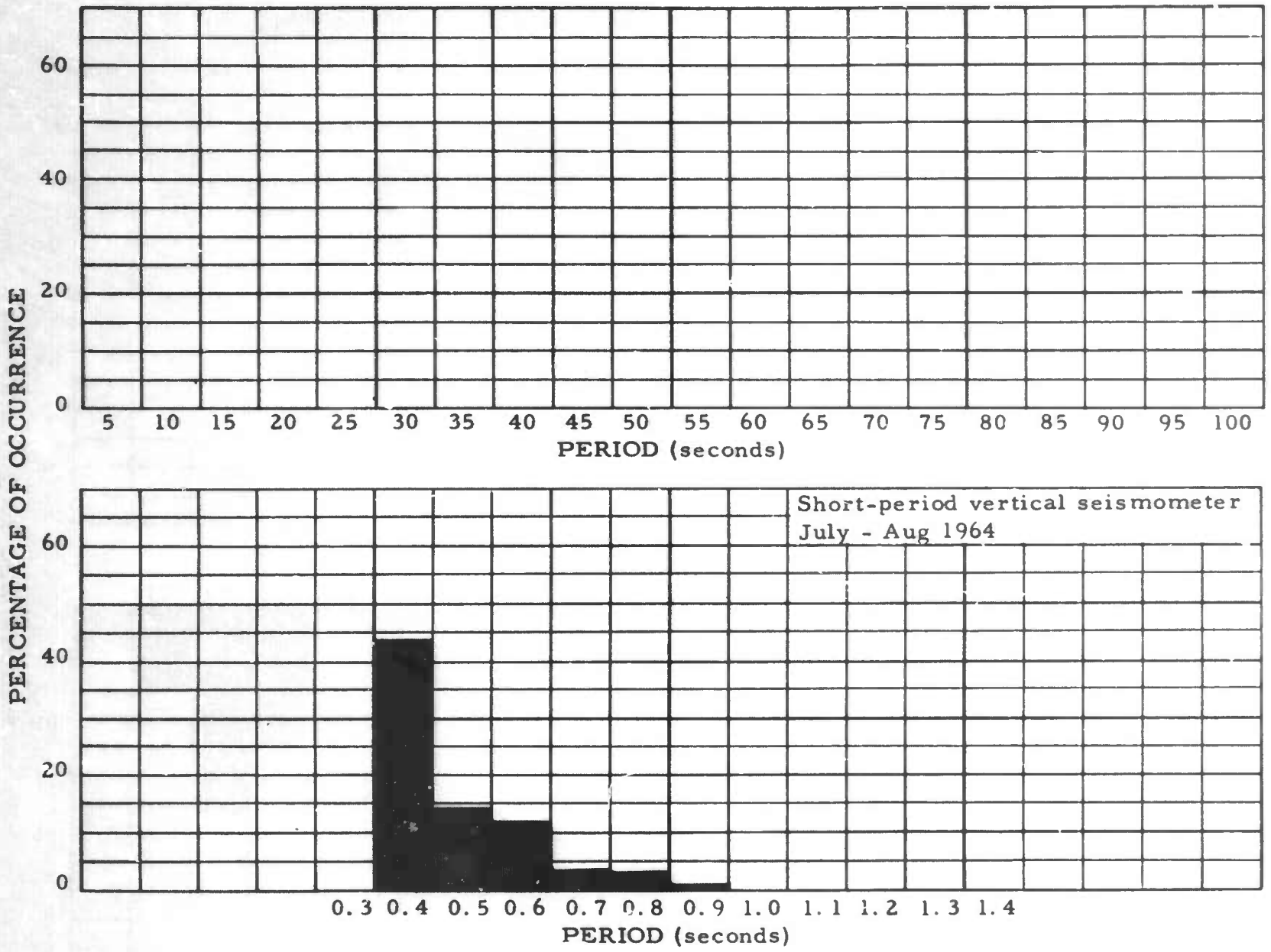
Percentage of occurrence for indicated periods for SN-AZ



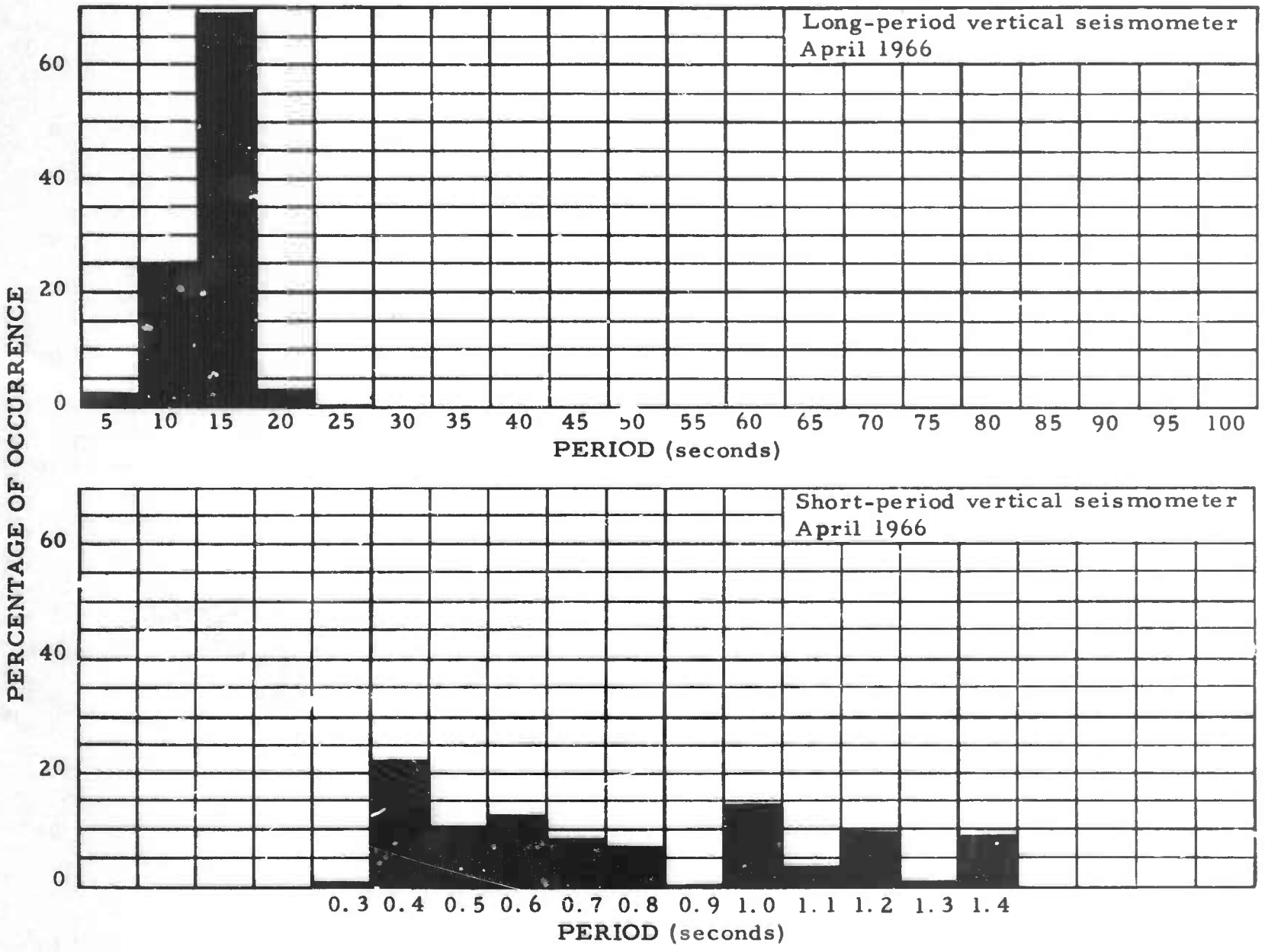
Percentage of occurrence for indicated periods for JR-AZ



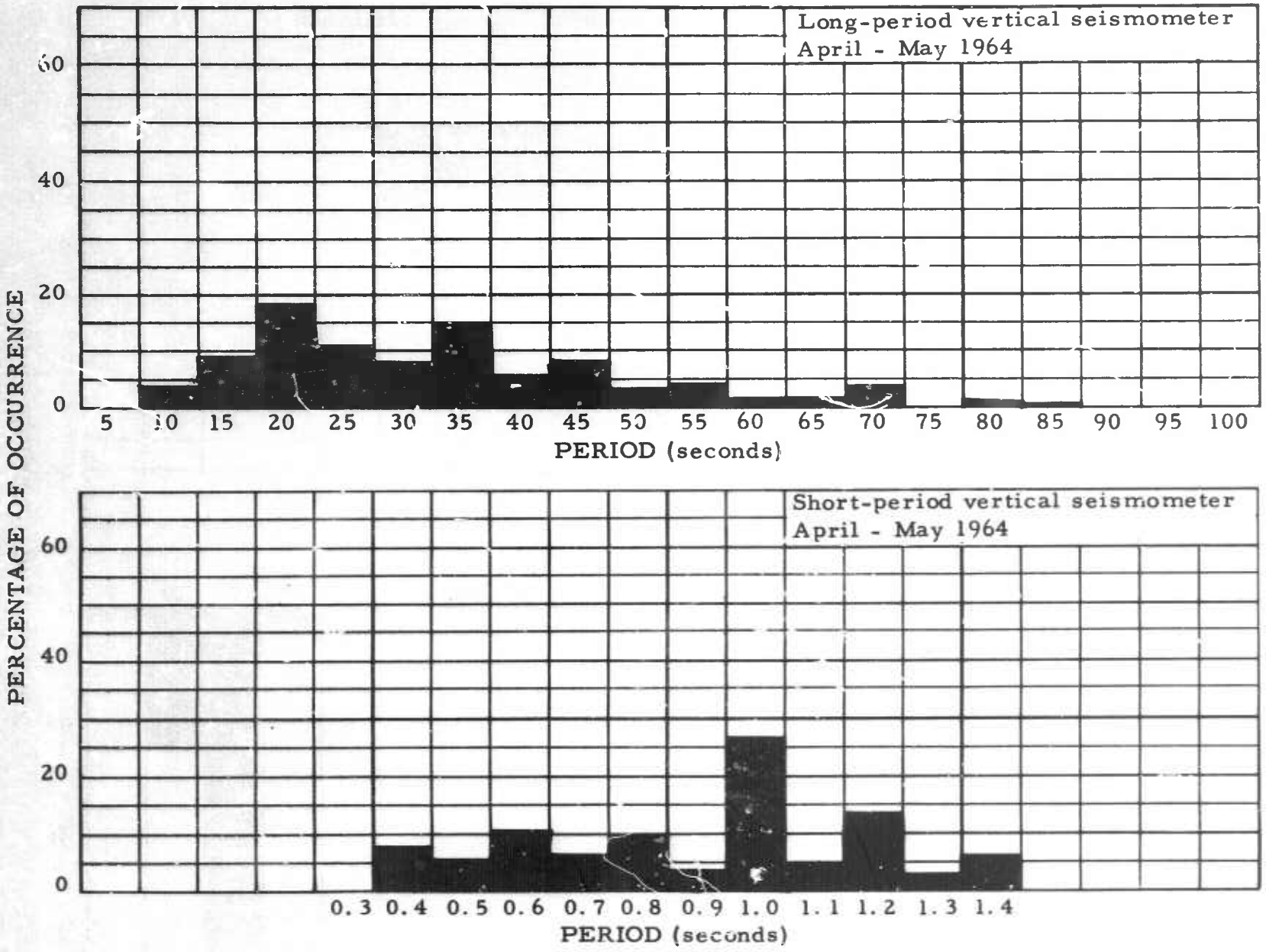
Percentage of occurrence for indicated periods for SG-AZ



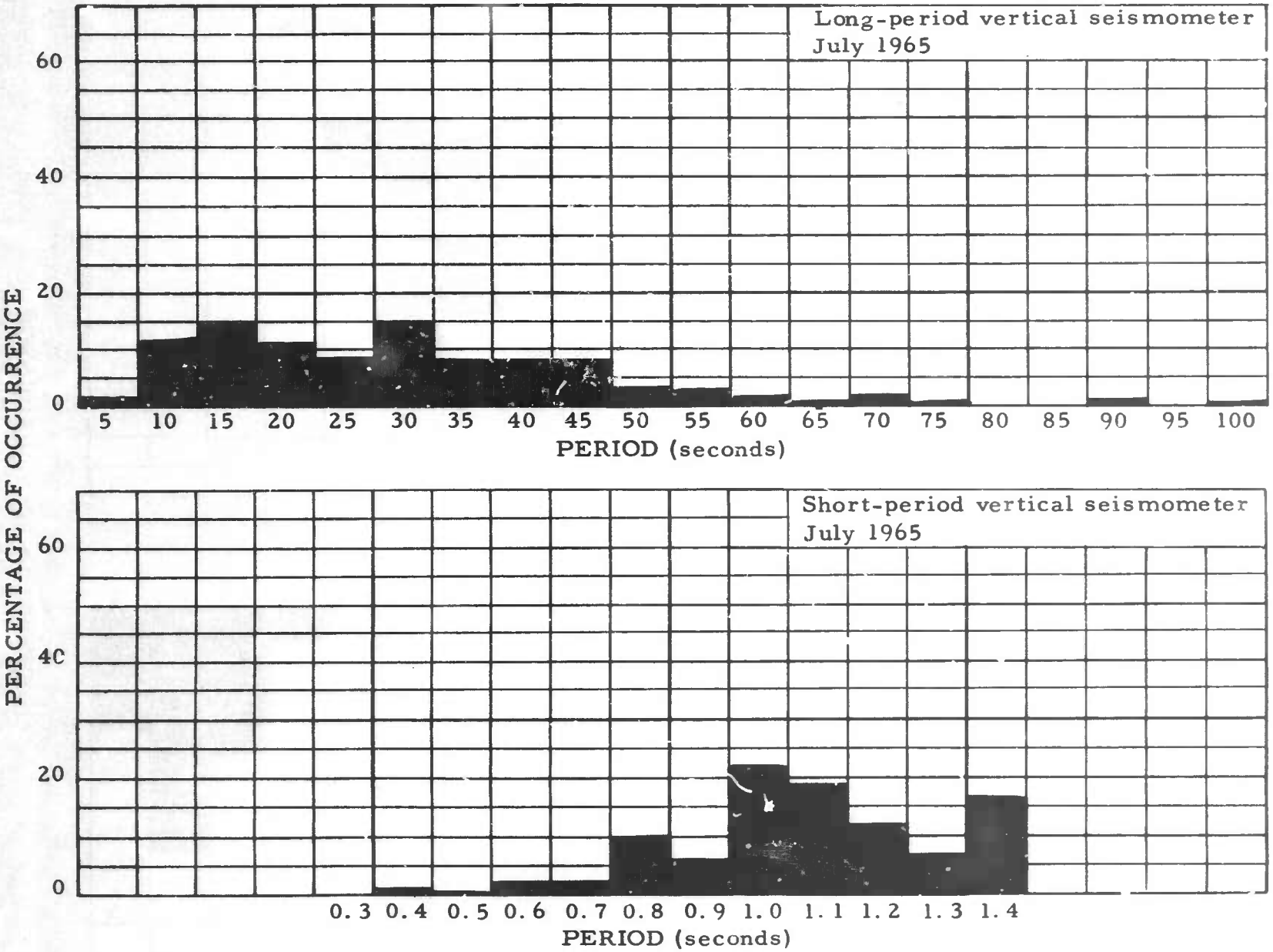
Percentage of occurrence for indicated periods for FO-TX



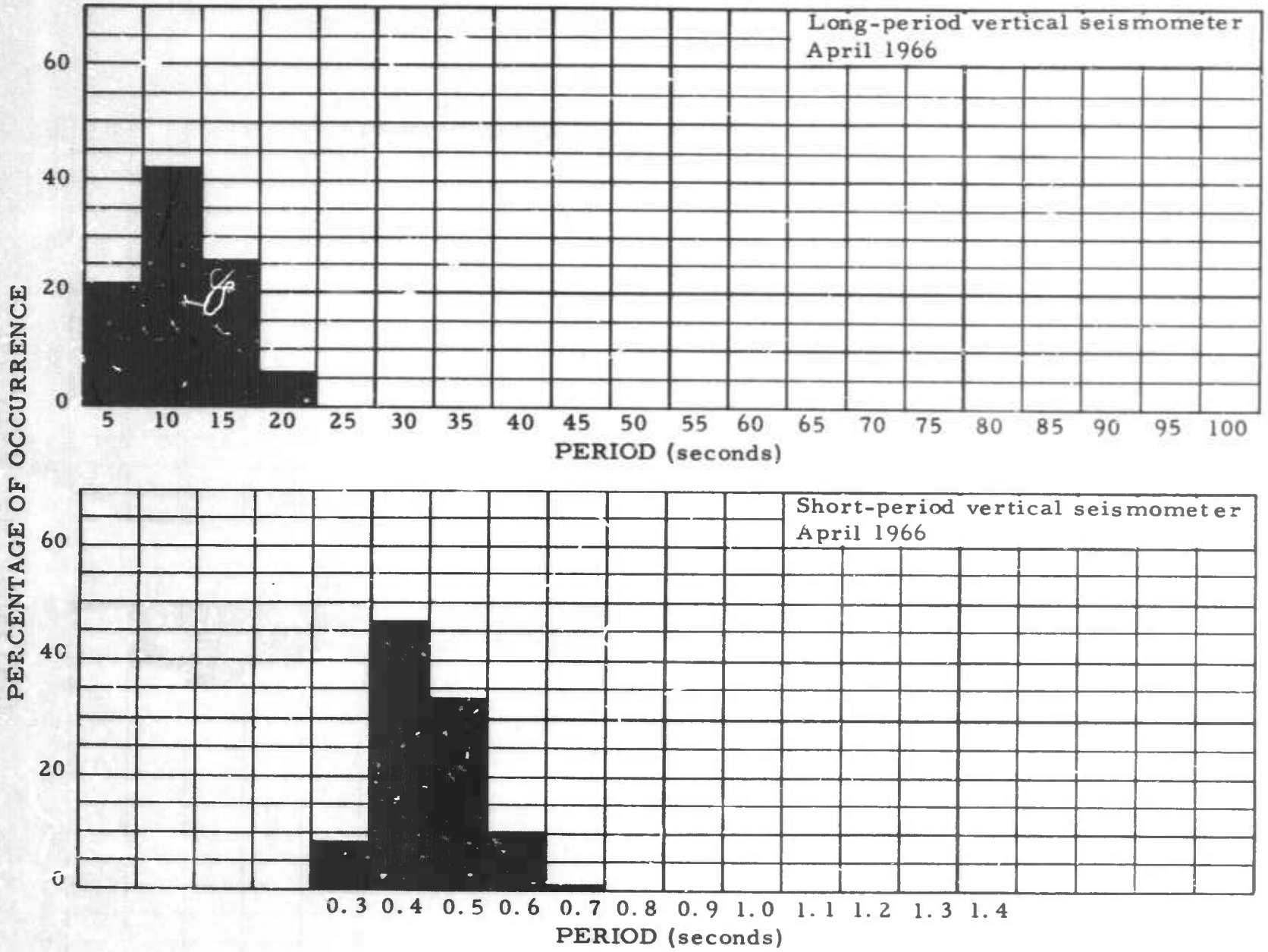
Percentage of occurrence for indicated periods for AX2AL



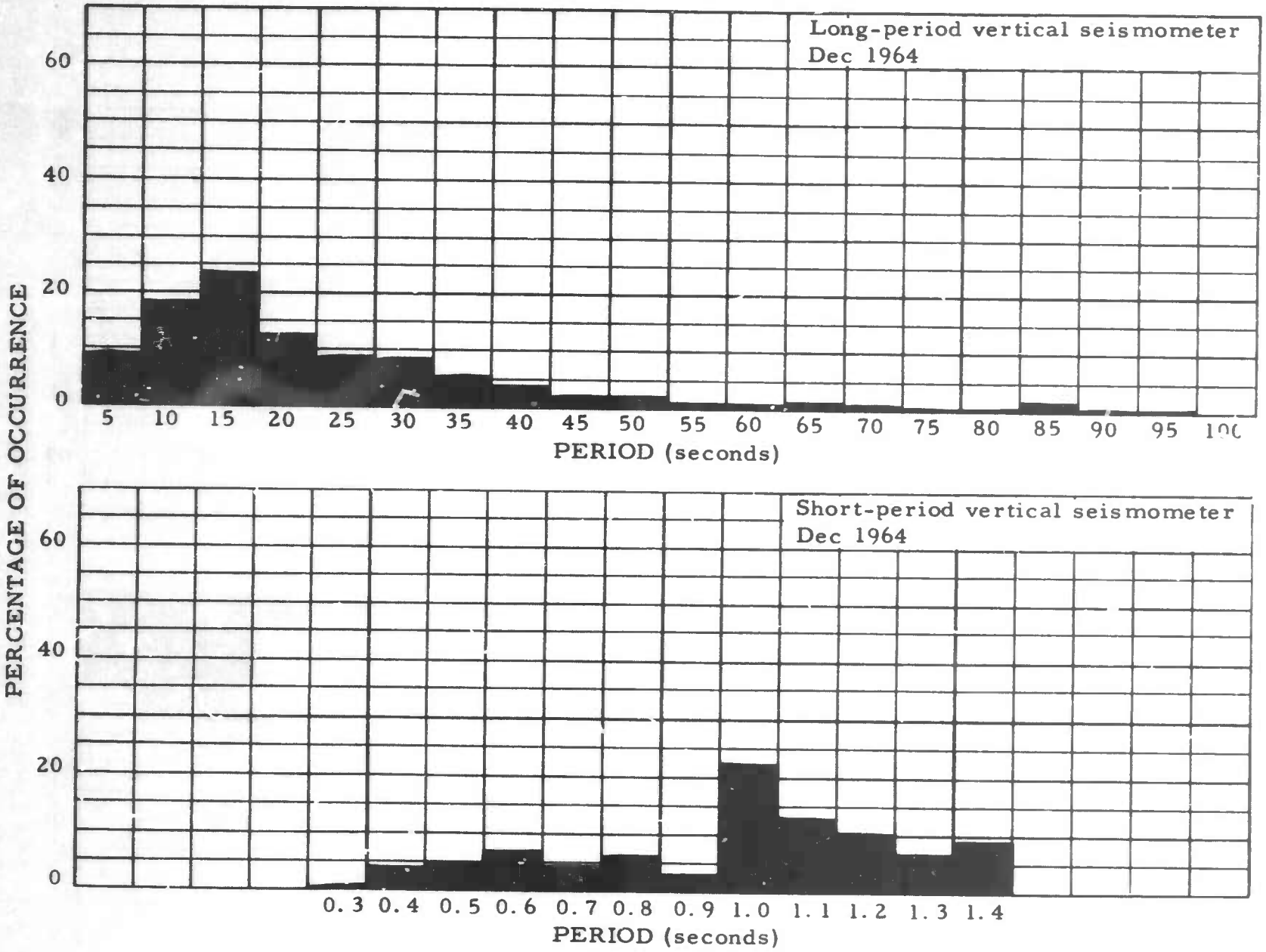
Percentage of occurrence for indicated periods for JU-TX



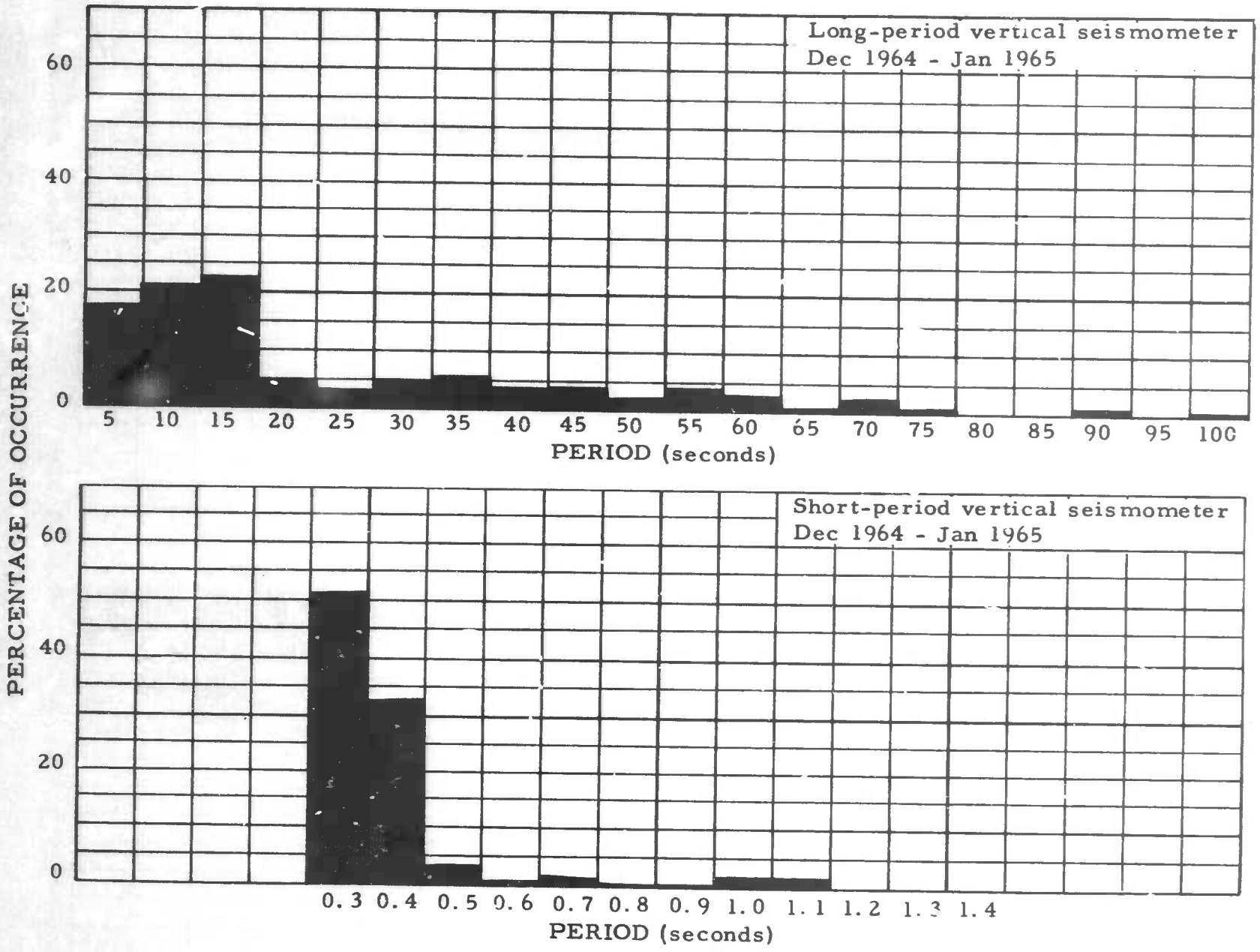
Percentage of occurrence for indicated periods for CG-VA



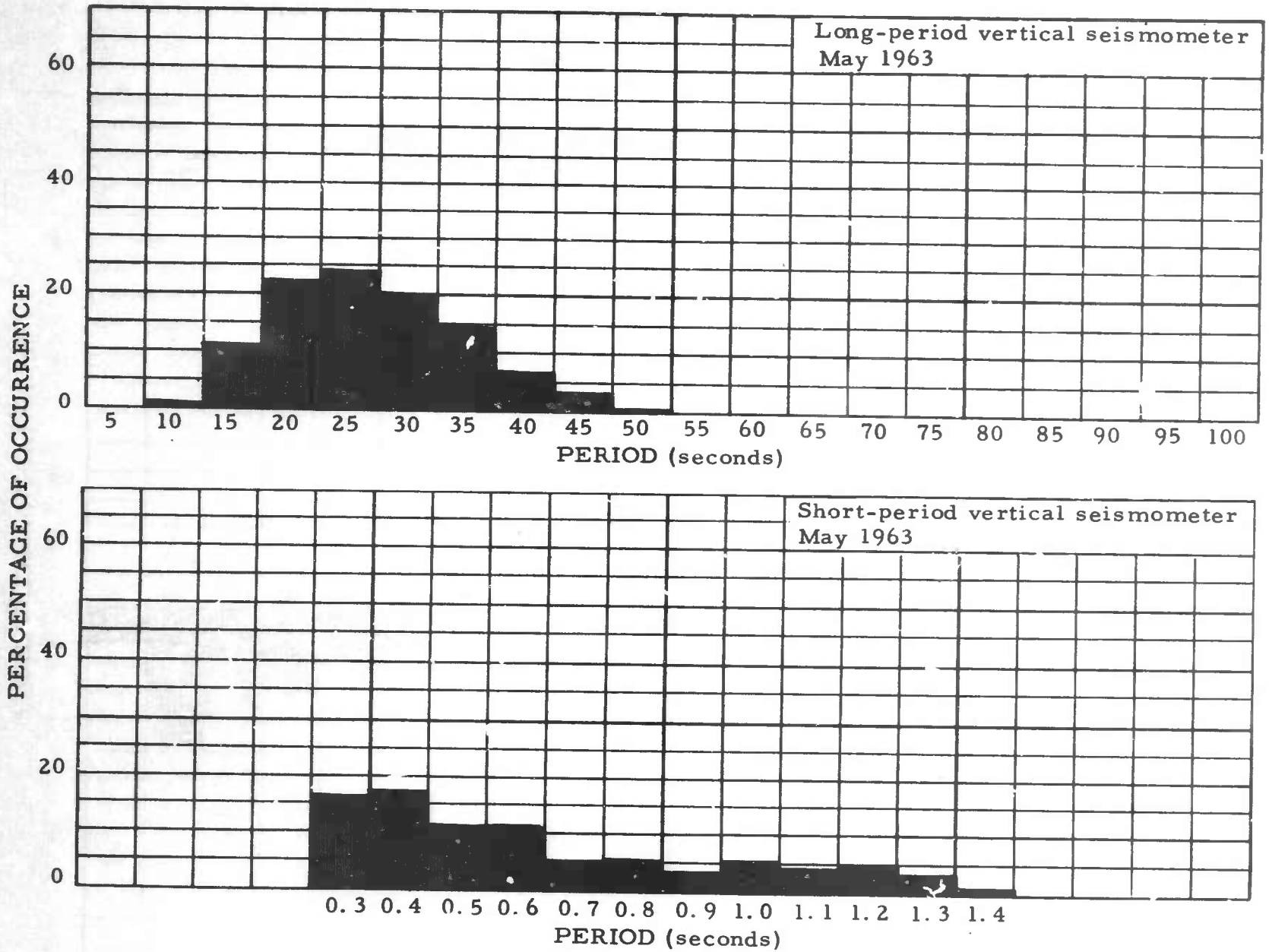
Percentage of occurrence for indicated periods for KC-MO



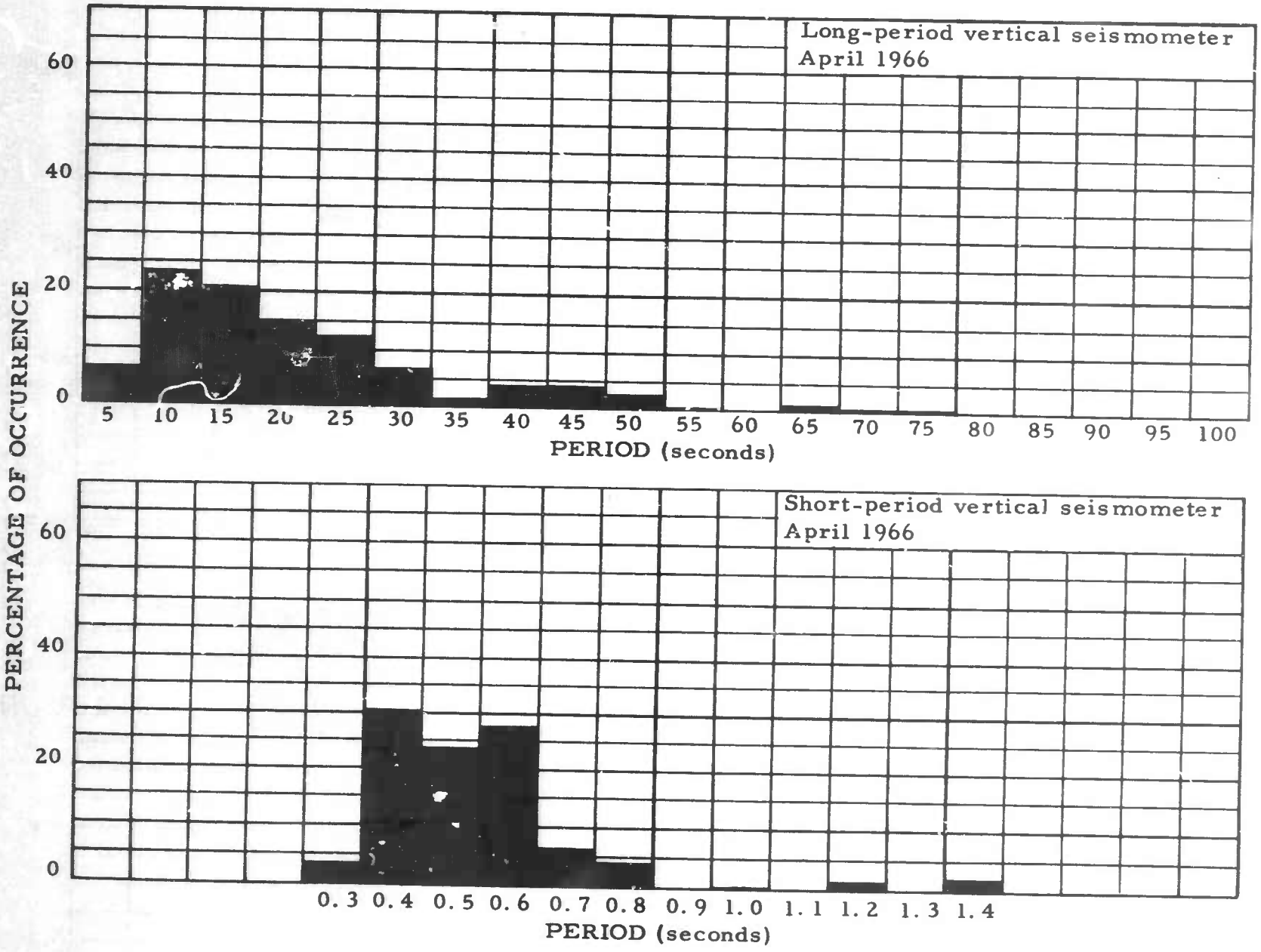
Percentage of occurrence for indicated periods for VO-IO



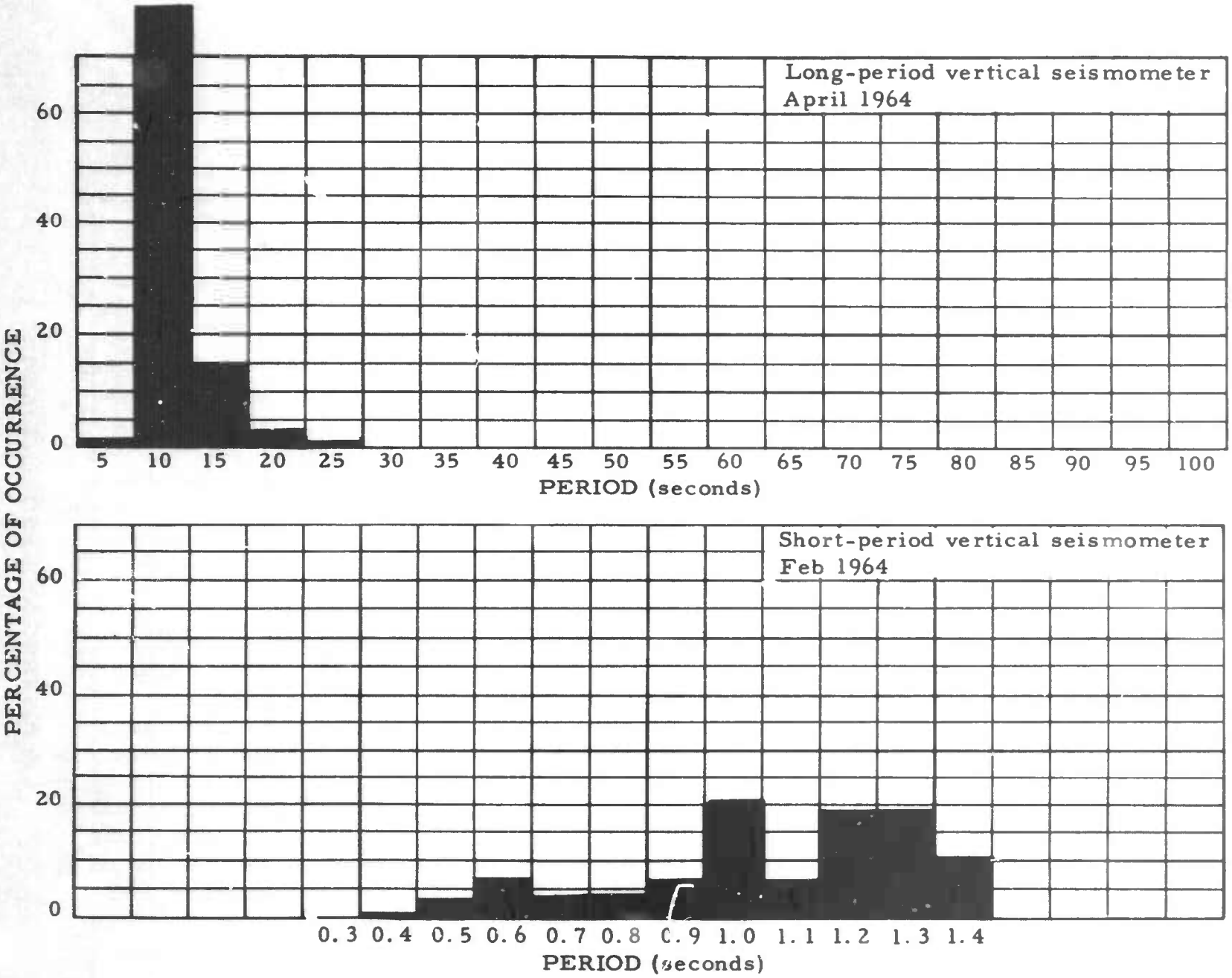
Percentage of occurrence for indicated periods for HD-PA



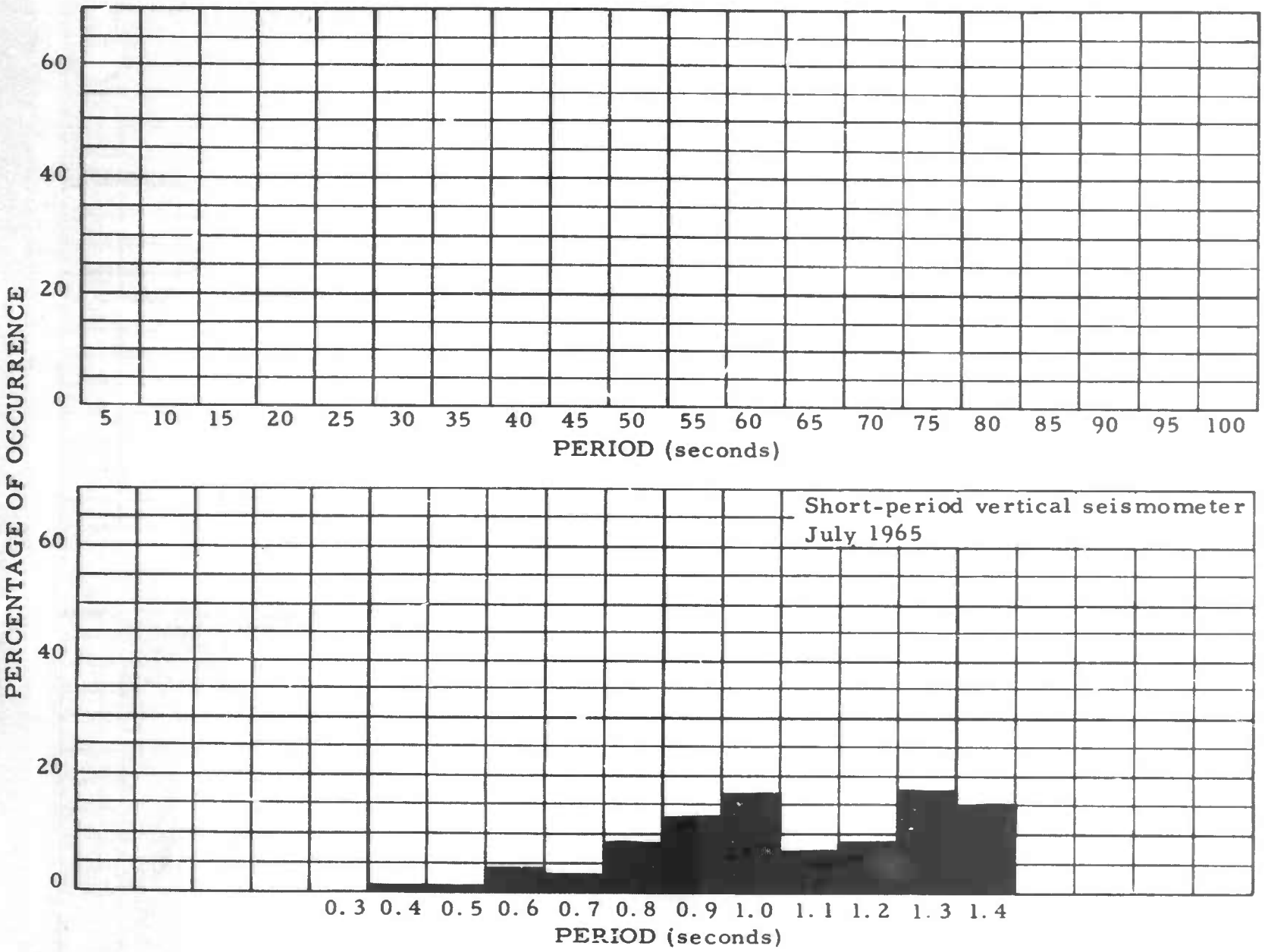
Percentage of occurrence for indicated periods for BR-PA



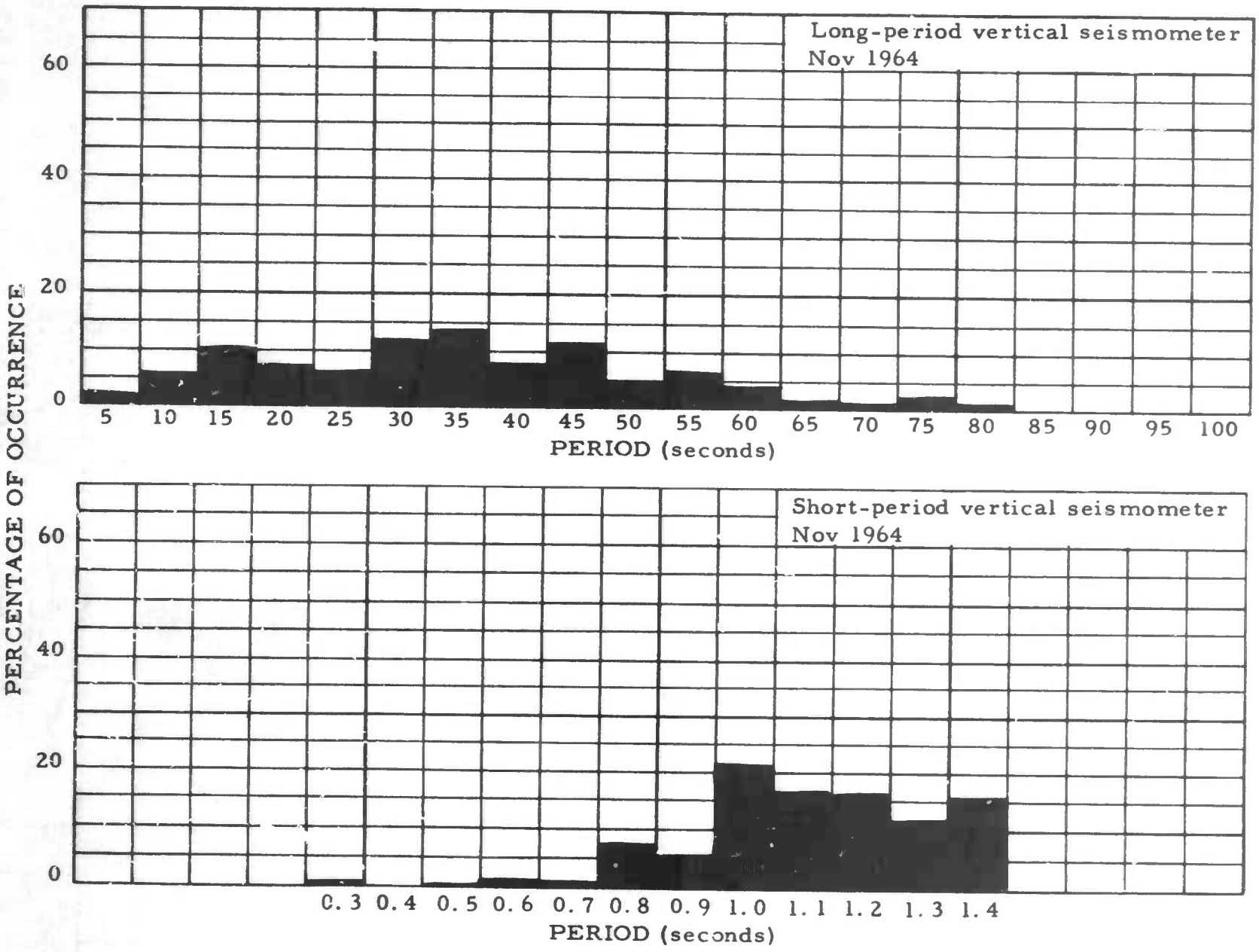
Percentage of occurrence for indicated periods for RG-SD



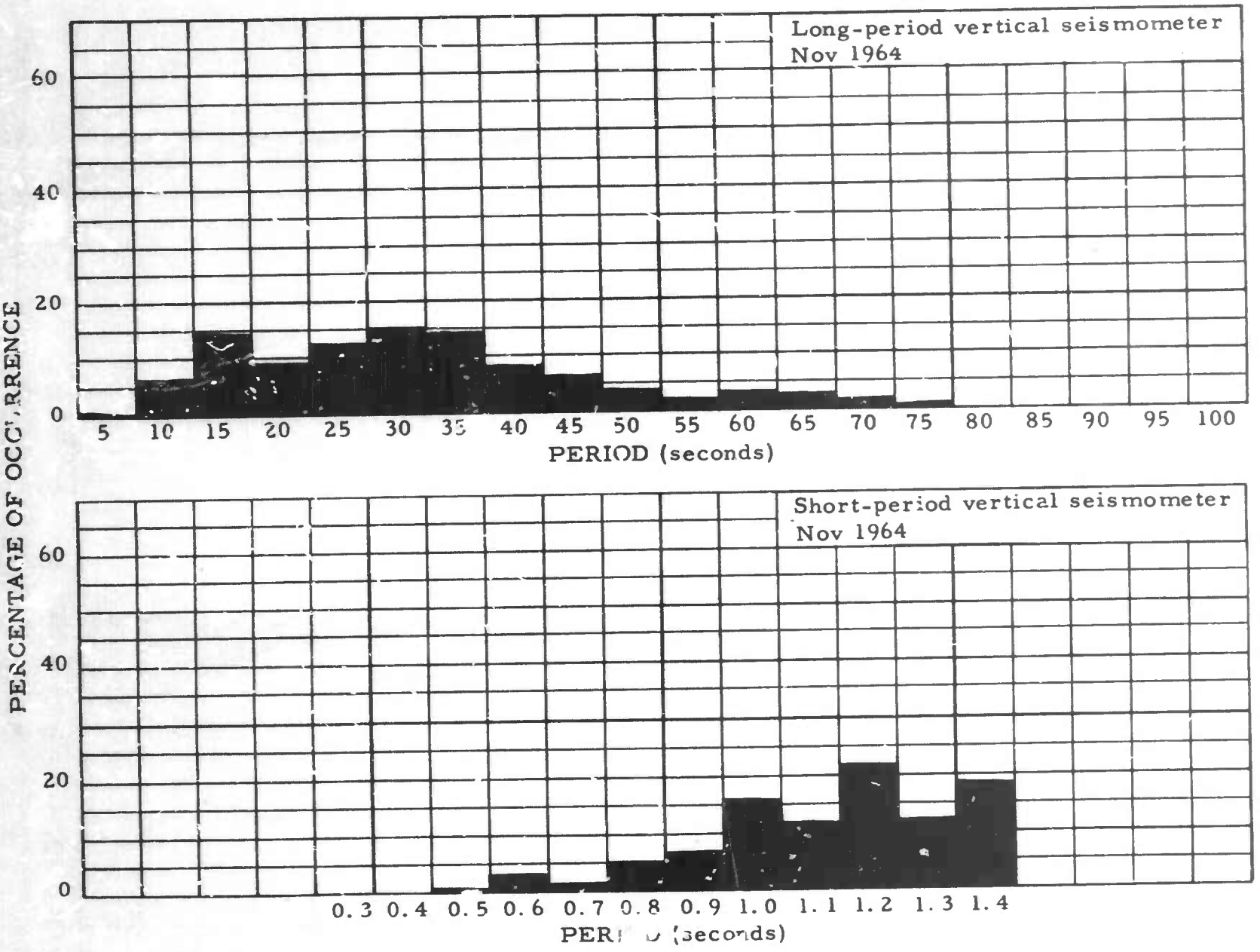
Percentage of occurrence for indicated periods for PI-WY



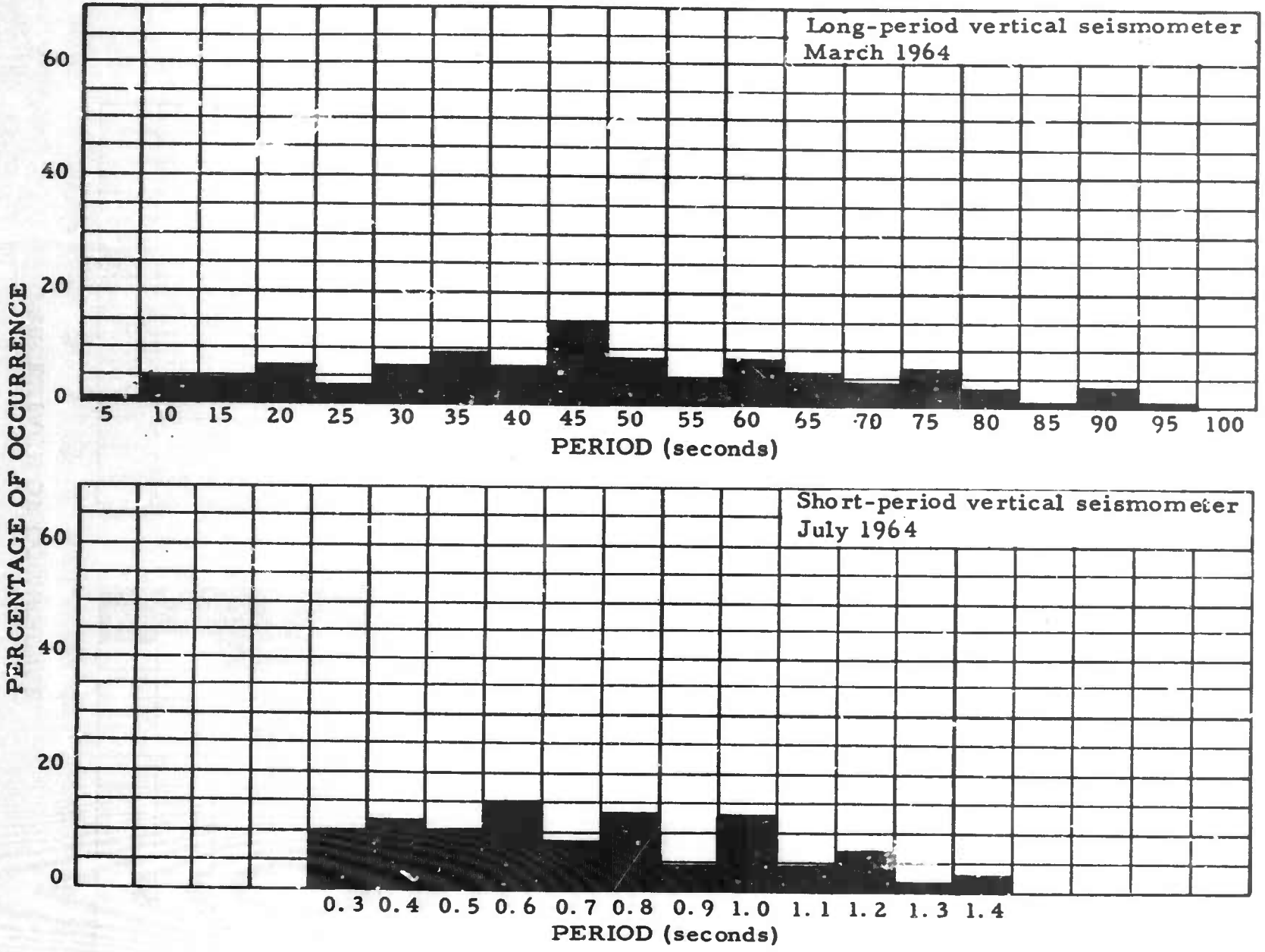
Percentage of occurrence for indicated periods for FN-WV



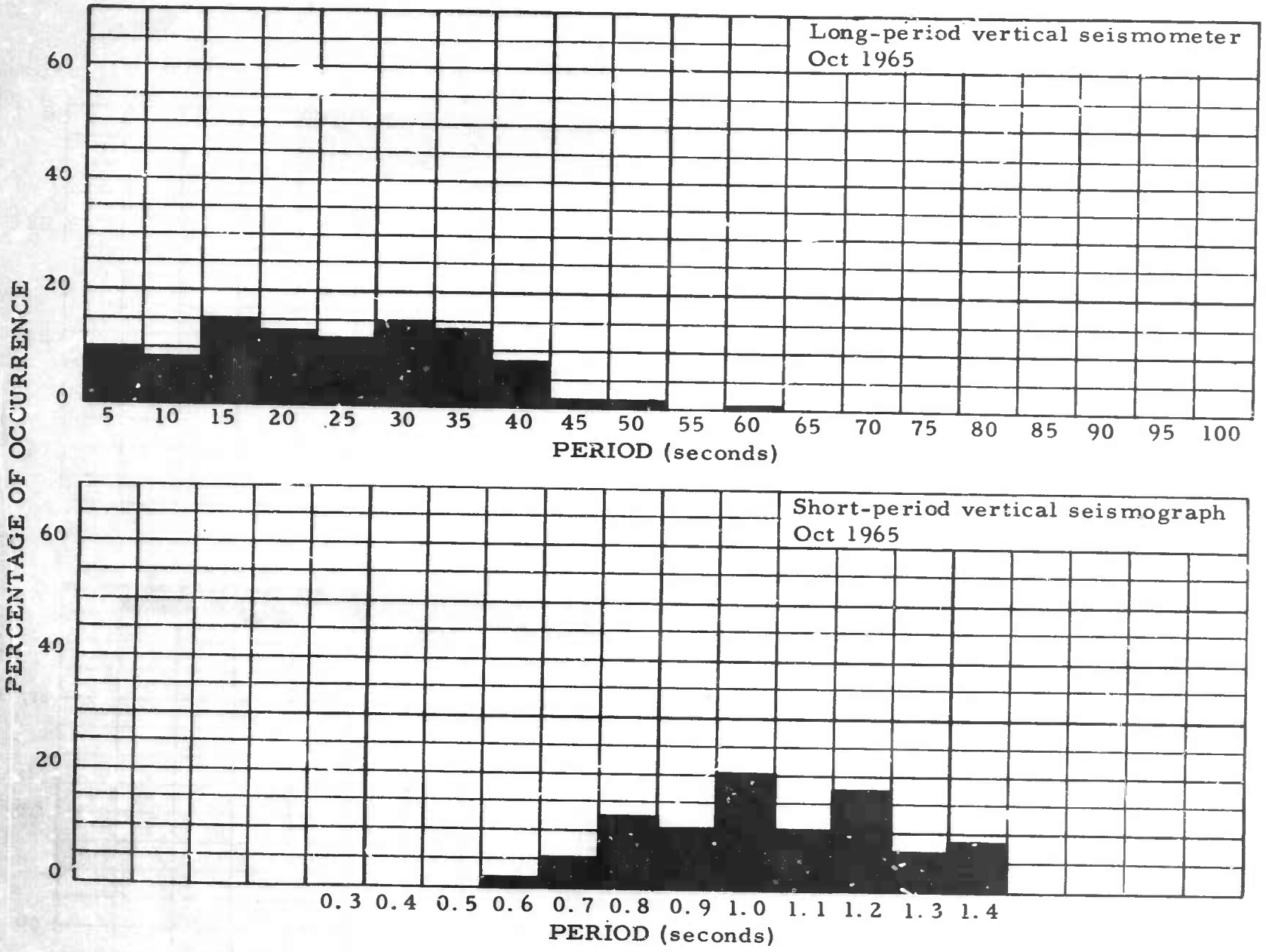
Percentage of occurrence for indicated periods for GP-MN



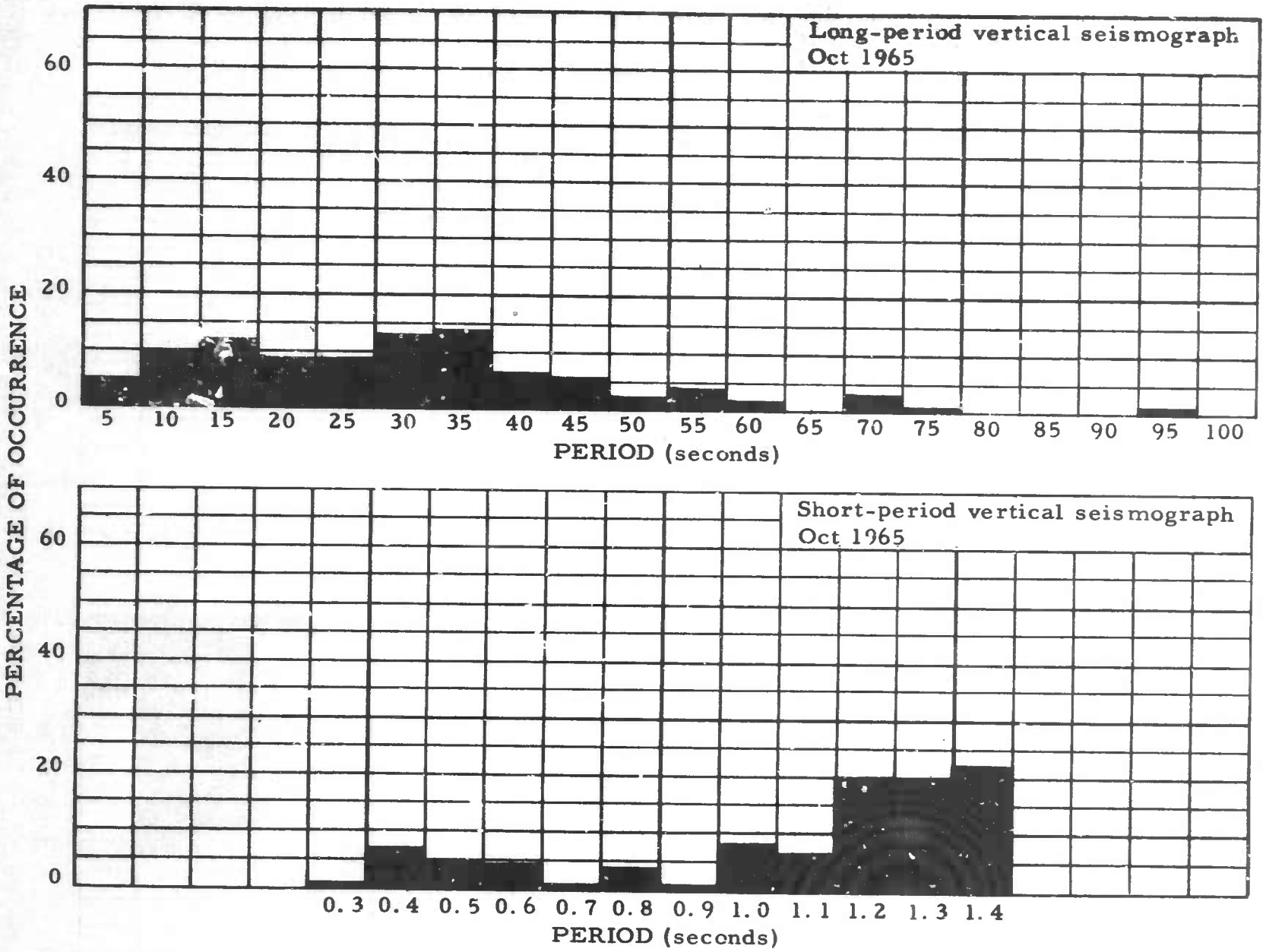
Percentage of occurrence for indicated periods for WF-MN



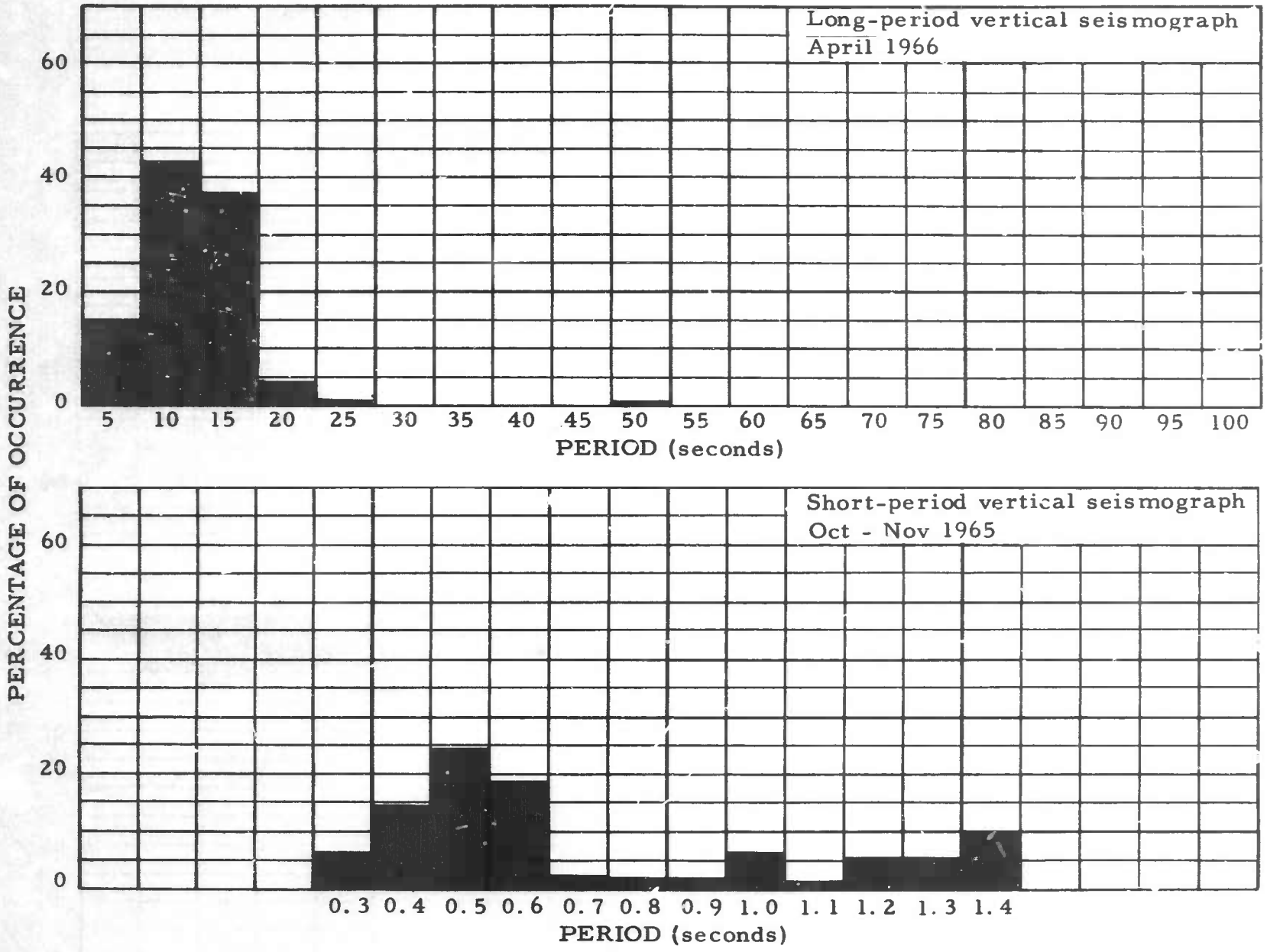
Percentage of occurrence for indicated periods for RK-ON



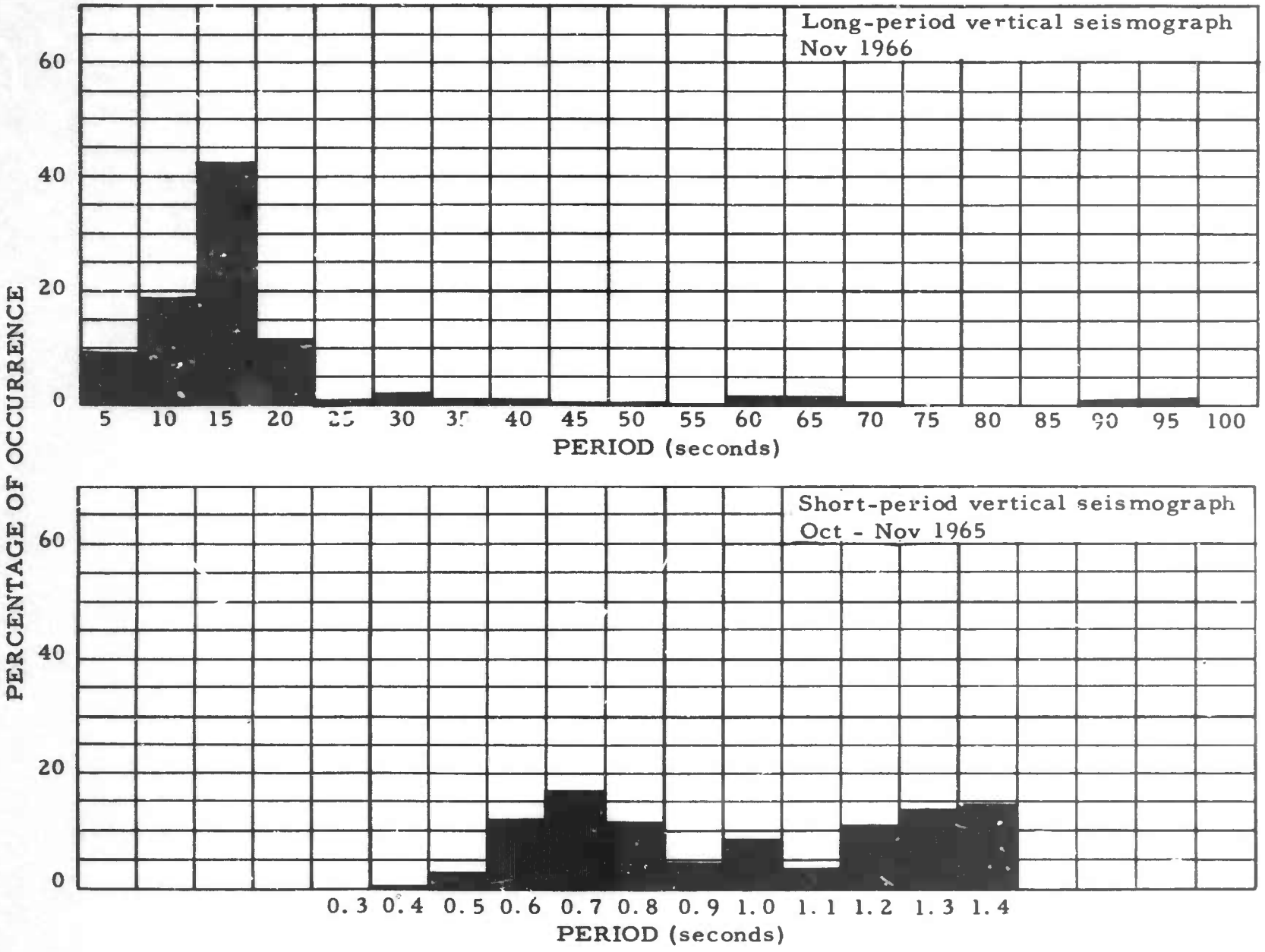
Percentage of occurrence for indicated periods for SV3QB



Percentage of occurrence for indicated periods for SI-BC



Percentage of occurrence for indicated periods for JP-AT



Percentage of occurrence for indicated periods for PG-BC

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)	2a. REPORT SECURITY CLASSIFICATION
GEOTECH, A Teledyne Company Garland, Texas 75040	Unclassified
	2b. GROUP

3. REPORT TITLE

Seismic Noise Survey, Volume 3, Long-Range Seismic Measurements Program

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Technical Data Report

5. AUTHOR(S) (Last name, first name, initial)

Pena, Carlos

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
29 June 1967	95	1

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
F33657-7-C-1457	
b. PROJECT NO.	Technical Report No. 67-19
c. VT/6703	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d.	None

10. AVAILABILITY/LIMITATION NOTICES

This document is subject to special export controls and transmittal to foreign governments or foreign nationals may be made only with prior approval of Chief, AFTAC.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
None	Air Force Technical Applications Center

13. ABSTRACT

This report is the third in a series of studies which evaluate seismic noise levels at LRSM sites. Data from the short- and long-period vertical seismographs from 33 sites are reviewed, and standardized data compilation methods are discussed. Cumulative probability distribution of amplitude curves and noise spectrum curves are developed for each site studied.

DD FORM 1 JAN 64 1473

UNCLASSIFIED

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Seismic Noise Survey Long-Range Seismic Measurement Program Short-Period System Long-Period System						

INSTRUCTIONS

1. ORIGINATING ACTIVITY: Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization *(corporate author)* issuing the report.

2a. REPORT SECURITY CLASSIFICATION: Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2b. GROUP: Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. REPORT TITLE: Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.

4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. AUTHOR(S): Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. REPORT DATE: Enter the date of the report as day, month, year, or month, year. If more than one date appears on the report, use date of publication.

7a. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7b. NUMBER OF REFERENCES: Enter the total number of references cited in the report.

8a. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.

8b, 8c, & 8d. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9a. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9b. OTHER REPORT NUMBER(S): If the report has been assigned any other report numbers *(either by the originator or by the sponsor)*, also enter this number(s).

10. AVAILABILITY/LIMITATION NOTICES: Enter any limitations on further dissemination of the report, other than those imposed by security classification, using standard statements such as:

(1) "Qualified requesters may obtain copies of this report from DDC."

(2) "Foreign announcement and dissemination of this report by DDC is not authorized."

(3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through

_____."

(4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through

_____."

(5) "All distribution of this report is controlled. Qualified DDC users shall request through

_____."

If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.

11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.

12. SPONSORING MILITARY ACTIVITY: Enter the name of the departmental project office or laboratory sponsoring *(paying for)* the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as *(TS), (S), (C), or (U)*.

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional.